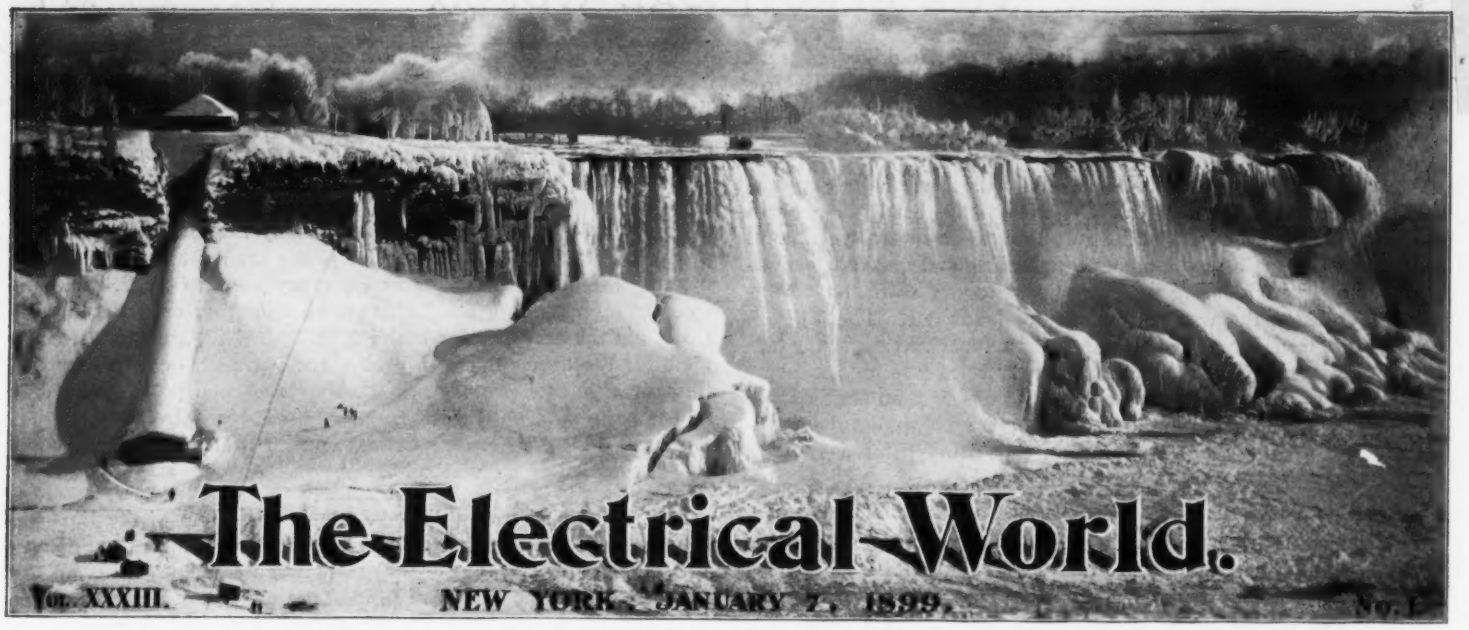

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ELECTRICAL ENGINEERING IN 1898 AND 1899.

The progress of electrical engineering during the past year has been subject to several strong modifying influences that have changed its direction, checked its growth in certain lines and stimulated it in others, so that comparing the year with those that have preceded it there are many notable differences.

The greatest influence modifying all industrial work in this country has, of course, been the war with Spain. The outbreak of the war naturally affected the investment of capital and put an immediate check on many large proposed undertakings. The development of electrical engineering was so rapid that this check, instead of reducing the amount of work in hand, merely checked its rate of increase, and even this influence was largely counterbalanced by the enormous demand of the Government for electrical apparatus and supplies, notably cables. The abrupt conclusion of the war has been followed by a prospect of American territorial and industrial expansion most bewildering in its suddenness and magnitude. This promises a greatly increased demand for American engineering work, and also a diversion into new channels of American capital which may check domestic progress, or at least call for a further inflow of foreign capital, which will continue our bonded indebtedness to older lands.

The greatest single event on the financial side of electrical engineering was the absorption of the Walker Company by the Westinghouse Electric & Manufacturing Company,[1] leaving only two companies—and those with quite amicable relations—manufacturing complete lines of electric lighting, traction and power transmission and distribution apparatus. These two companies have steadily broadened the scope of their operations, one of them, the General Electric Company, now manufacturing from raw material in its own shops perhaps a greater variety of apparatus and supplies than any one industrial concern the world over. The other is part of an association known as the Westinghouse Companies, which—to the great benefit of the consumer—contracts for electrical power installations of any magnitude complete, a recent single contract of this kind calling for the payment of over $5,000,000.[2] The General Electric Company has, during the year, greatly improved its financial status by a 33 1-3 per cent. reduction of its capitalization.[3] The general tendency of the last few years toward the consolidation of opposing interests and the closer relations of allied interests in neighboring districts has been followed by some consolidations of very large operating companies, mainly in the central station and

[1]See The Electrical World September 24, page 309. [2]See ibid. December 24, page 675. [3]See ibid. August 27, pages 201, 219.

traction fields, notably the lighting interests of Brooklyn,[4] of traction companies in Boston and New York, and traction, electric lighting, subway and other companies in the latter city.[5]

Another step forward has been taken in the line of the exportation of electrical and steam machinery. This has been going on in the direction of the Orient and South Africa for several years, and in the item of traction equipments toward England and other countries claiming engineering progress equal to our own and advantages over us in the way of low cost of labor, etc. The English have apologized for placing their orders for electric-railway apparatus on this side on the ground that America was for local reasons ahead in the development of trolley lines, but no such excuse can be made for the recent order of three 2500-hp lighting generators and engines built complete in this country for a London central station.[6]

The electric railway field has not seen the expected extension of its methods to suburban and interurban traffic now hauled by steam on private rights of way. The third-rail equipment of branches of the New York, New Haven & Hartford Railway has been in continued service, but not materially extended. Third-rail traction has been extended on the elevated railways of Chicago and on the New York & Brooklyn Bridge, and many of the difficult problems of this work are at these places being brought to a solution. Surface traction using the overhead trolley has been brought to a remarkable state of standardization, and no developments of any consequence are noticeable in this field during the last year. The almost mad rush of the growth of street railways has received a check, owing to the fact that there are practically no more cable, horse or other systems to be re-equipped, but both operating and construction companies are kept busy with extensions, renewals and repairs. The open-conduit system of conductors has proven itself an almost unqualified success in those cities of America where it has been tried, namely, New York[7] and Washington[8]. The bugbears of breakdown and trouble have proven largely illusions, and even that of high first cost is not as bad as was feared, although prohibitory to the use of such systems in any but the large cities. Traction systems have grown to such an extent that they now call for steam plants larger than those in use for any other service whatever. There is now in course of construction in New York city one which will have an output at its most economical rating of 44,000 horse-power, and another planned for an economical rating of 64,000 horse-power.

In traction work, as well as in central stations, isolated plants, telephone, telegraph, and, in fact, all uses of electricity, the most marked improvement has been the appreciation and adoption of the storage battery. It is now estimated that there are in use in the United States about 2500 tons of storage-battery plates. The greatest demand has been from direct-current central stations, and the largest battery in the world, weighing 500 tons and capable of storing over 3000 kw hours, is in such use in Chicago.

In central-station work the importance of the high cost of the peak of the load curve and the consequent necessity of a graduated tariff, dependent in some way on the nature of the demand, has been for several years persistently emphasized by the technical press and convention speakers. During the past year this seems to have been generally appreciated, and a demand has consequently grown for multiple-rate meters. Two of these are now on the market, one designed to give a discount based on the height of the peak of the consumer's load curve[9] and the other based on the time distribution of the demand.[10] Central-station practice has also seen, during the year, a steady continuance of the overthrow of the open arc by its modern rival, the enclosed arc, the placing on the market of many makes of enclosed arcs for alternating circuits, and the general perfection of alternating-current, high-tension and transforming apparatus, owing to the pioneer work of several liberal-minded companies.[11] The scare caused by acetylene gas has subsided, as the latter, although remarkably successful, is filling a field to which it is peculiarly adapted, and which does not to any great extent cut into central-station loads.

The year has seen an unprecedented development of water-power plants and long-distance transmission lines. The success of early systems, local patriotism and the desire to develop manufacturing advantages, among which cheap power is often too highly rated, has encouraged this movement, which in many instances will probably prove itself rather rash. Most such plants are built with the idea of meeting the demands for power for many years to come. The extremely high ratio of fixed charges to operating expenses in this work and the necessity for building an hydraulic plant almost complete for the development of even a few per cent. of its power will limit or eliminate profits with the low loads and poor load factor that may be anticipated for many years. The requirements, limitations and difficulties of long-distance power transmission have come to be much better understood[12].

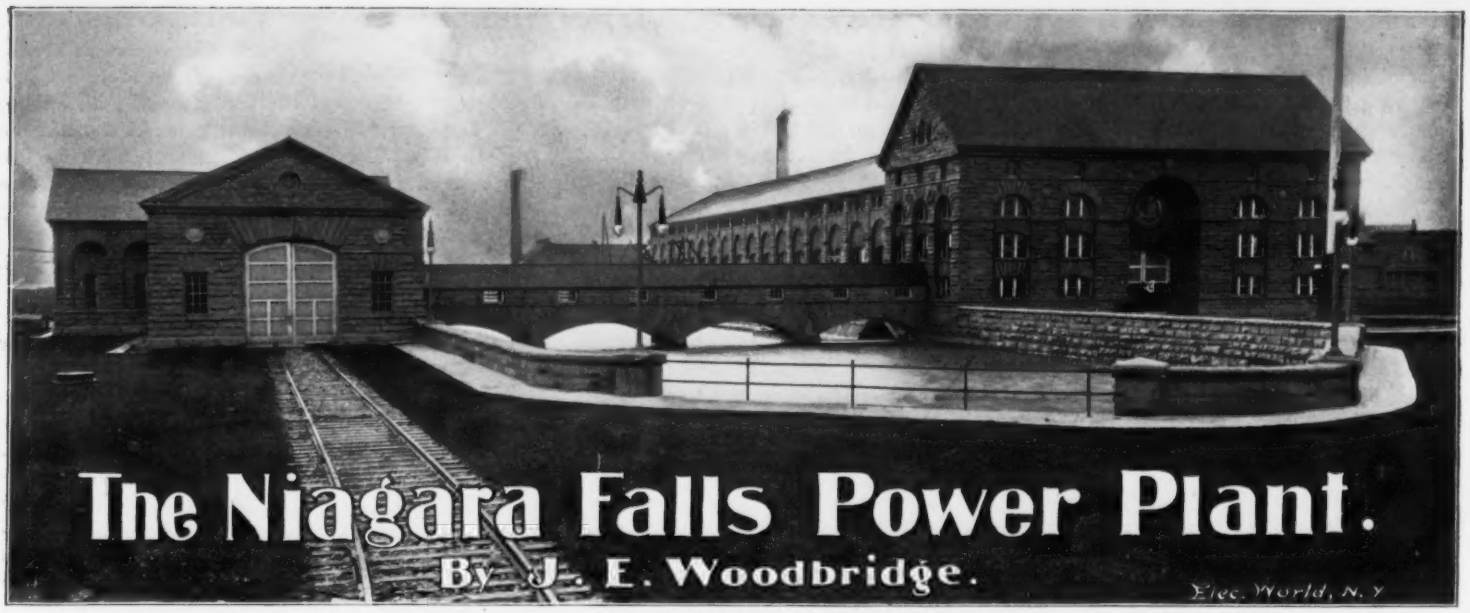
In telephony, the long-distance telephone system of the East has been extended in one direction to Omaha, Neb., and in another to Little Rock, Ark., giving distances between extreme points on the system of about 2000 miles. With the present size of the trunk wires it is difficult to get continuous good conversation over distances greater than 1000 miles. Telephone exchanges, both Bell and independent, are being rapidly equipped with central-energy systems, thus doing away with magneto generators and primary batteries—both sources of a great part of the troubles of telephone systems—at the subscribers' stations. The independent telephone companies have halted in their wild rush to secure franchises and install new exchanges and found time to take a look around. They seem to be somewhat troubled by the poor quality of the apparatus they have installed, due in part to their youth and poverty, the cut-throat competition of independent manufacturers and the large number of patents on apparatus owned by the Bell interests. The community of interest and necessity of interurban service is naturally drawing the independent operating companies into closer and closer relationships, which will be greatly to their advantage in the competition they are carrying on with a common rival. Wireless telegraphy has been the most sensational development of the year in the electrical line, and has afforded—unfortunately with the aid of several well-known scientists—the daily and Sunday newspaper writer a fine field for the exercise of his versatile imagination. The development of the year promises considerable addition to the scientific knowledge of ether waves and their transmission, and possibly, if the delicacy of the apparatus and its liability to disturbance can be overcome, some practical application in cases where communication by other means is especially difficult.

There is great cause for rejoicing in the fact that a résumé shows on the death roll the name of no one specially honored among American electrical engineers. Our foreign associates cannot congratulate themselves in the same way. In England, Dr. John Hopkinson is widely mourned, as is also Latimer Clark. In France the roll includes Camille A. Faure and M. de Meritens, whose names are familiar to electrical engineers the world over.

The immediate future, and particularly the new year, holds out a most hopeful prospect. An industrial prosperity, deplorable as its cause may be, can be anticipated similar to that following the Civil War, and industrial at the present time means engineering. Electric traction promises to continue in the same set lines that it has already established, while central-station work shows prospect of greater changes almost threatening revolutions. Among these are the growing use of the gas engine and the coming trials of steam turbines[13]. Electric automobiles promise a new load of rapid growth and no inconsiderable magnitude and with a very desirable load factor. The coming expiration of the three-wire patents may cause in this country the introduction of 450-volt three-wire systems like those so generally used in England. Electrolytic and electric furnace chemical processes appear at present to be the embryo of a tremendous use of electrical power which hydraulic plants alone will not satisfy, and which may aid in leveling up the load curve of large and economical steam stations. In almost every line the present condition seems to be one of health and vigor and promising a most prosperous and happy new year, a promise which The Electrical World most sincerely wishes may be amply fulfilled.

[4]See The Electrical World October 15, page 403. [5]See ibid. December 24, page 678. [6]See ibid. August 13, page 168. [7]See ibid. September 10, pages 254, 258. [8]See ibid. December 31, page 707, et seq. [9]See ibid. November 26, page 569. [10]See ibid., current issue, page 30. [11]See ibid. December 3, page 579, et seq.

[12]See The Electrical World November 26, page 557, and December 3, page 592. [13]See ibid. August 13, page 168.



INTRODUCTORY.

There has been so much literature published about this unique piece of electrical engineering that it is well to state at the outset that this article does not pretend to be a complete descriptive one. The subject will be treated from an engineering standpoint, giving in many instances the reasons for adopting the main features and the interesting details involved in the design, the realization of the performance anticipated, some of the conclusions which may be drawn from the valuable experience obtained, and particularly the changes and modifications incorporated in the additions which have been under construction during the last two years and have just reached completion.

As noted in the conclusion below, this installation, considering the peculiarity and magnitude of the problems involved in its design, has undergone remarkably few modifications, and those only in matters of detail. Still, small details are of large size physically and of great importance in a plant of this magnitude, and an explanation of the improvements may be a guide to any others who may be somewhat similarly situated, although, of course, this installation is not a typical one, but stands alone by reason of its magnitude and peculiar local conditions.*

THE SUPERSTRUCTURE

The extension of the main building has been carried out with exactly the same pleasing architectural design as that of the part first constructed, the only apparent difference being the lighter color of the more freshly quarried limestone and the careful avoidance of all marks of quarrying tools. The northern end or front of the building remains exactly the same as before, with its offices and the group of three rotary converters for local electric-railway supply. The new southern end is again closed by a temporary wall with the anticipation of further extension. The main dynamo room is now 457 feet in length, with space sufficient for ten of the 5000-hp machines, of which eight are already installed and in working order. The high-tension transformer house and the wire passage leading to it remain as before. The interior is heated electrically, the machine losses, which, when the eight machines are running loaded, will amount to about 800 or 1000 electrical horse-power, being expected to maintain a comfortable temperature in winter.

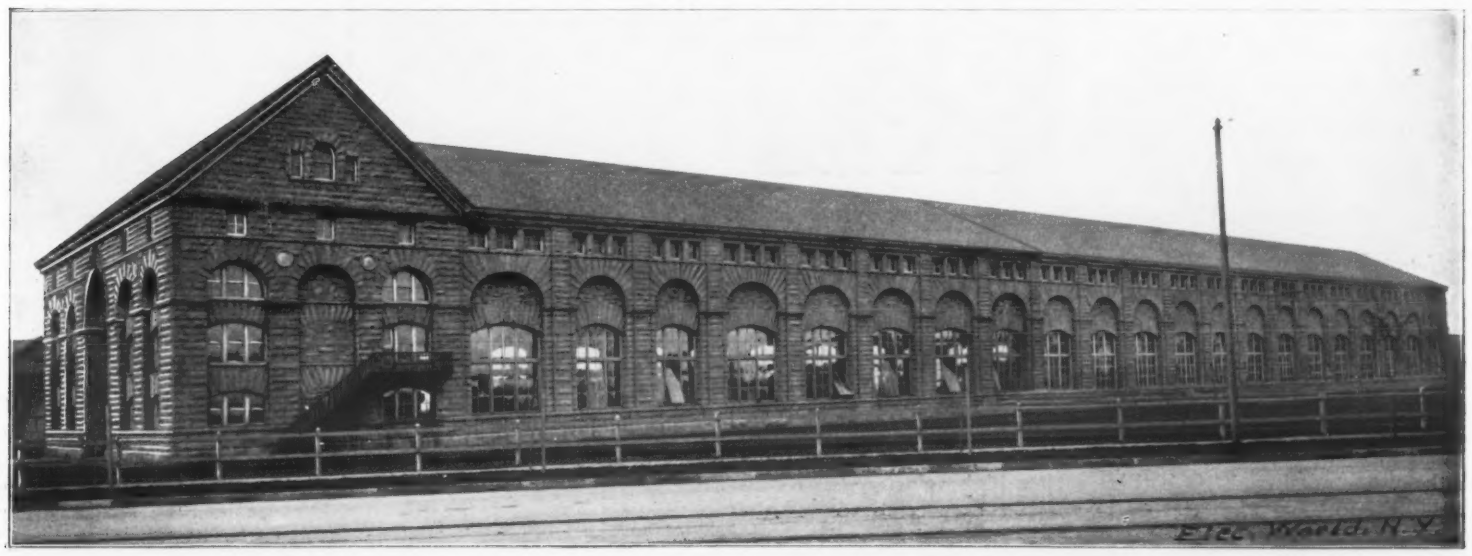
The single-motor 50-ton Sellers crane spanning the house serves not only the main floor but the wheelpit below, and is fitted with a separate rapid hoist with a rope long enough to reach the tail race about 200 feet beneath it.

THE WHEELPIT.

The extension of the mammoth excavation in the rock, known as the wheelpit, differs quite generally from the original cut for the four northernmost wheels. The rock of the extension was quarried not by drilling and blasting, leaving rough walls as in the old pit, but by channeling machines, forming the wall faces, the core being afterward drilled and blasted out in steps. A new channel being cut every 6 feet, the outward and downward inclination of the surface left by the channeling machine requires an offset forming a step or shelf about 6 inches wide at each of the 6-foot benches, giving the walls during the process of construction a saw-tooth vertical profile, as is clearly indicated in a view of the pit under construction, which is shown in Fig. 3. The walls were then bricked up to a thickness of about 32 inches at the bottom and 8 inches at the top.

Between the rear course of brick and the face of stone is an occasional horizontal course of hollow brick forming passages which gather the water which enters through the openings of the rock and discharge it into vertical, 8 x 8-inch flues, left in the brickwork at intervals of about 10 feet. These flues, or "weeper boxes," as the engineers in charge have termed them, carry all this leakage into the tail race below. Owing to this construction, and the fact that the bricks are laid in Portland-cement mortar, not a drop of water falls in the new part of the wheelpit, while at the bottom of the old part there is a constant "weeping," or fall,

*See also THE ELECTRICAL WORLD, June 5, 1897.



resembling in places that of a very heavy thunder shower. The pit is now 426 feet long, 18 feet wide and 180 feet deep, and gives room for ten penstocks and wheels, of which eight are now in place, and about 20 feet to spare for use as a hoisting shaft when further extension is undertaken.

Those who have followed the progress of this work may remember the rumor circulated about a year and a half ago of the creeping together of the wheelpit walls, threatening the whole hydraulic equipment with a fate resembling that of the prisoners in the collapsible cells of the Spanish inquisition. Something of this kind was anticipated when the continuous cut was planned, but it was considered preferable to brace the walls by artificial means rather than to leave struts of the original rock, owing to the friable nature of the latter and the occasional strata of Niagara shale. To stop the movement great concrete brace walls or partitions have been put in below the turbine deck between each two wheels, dividing the lower part of the pit into stalls. These brace walls are about 13 feet thick and 22 feet high, and rest on brick arches crowning the lower part of the pit, which for a height of 21 feet serves as a tail race discharging into the great tunnel leading to the portal in the gorge below the falls. The concrete brace walls, a clear idea of which can be obtained from the drawing, Fig. 32, on page 21, are completely encased in brick laid in Portland cement, as is all concrete in this subterranean work.

Embedded within each of these brace walls and also scattered generally throughout the pit are heavy, cast-iron horizontal struts with a Phœnix-column cross section, which will be clear on reference to the same drawing. These heavy struts have each a cross section of metal of about 180 square inches. They are slipped in between two cast base plates bricked into the walls, and with an extended bearing on the surfaces of the rock, which are faced up to a true vertical at these points. A gauge for measuring the distance between the pit walls with micrometer accuracy has given no indication of perceptible movement since August, 1897, so that in all probability no further bracing, which could be added if found necessary, will be put in.

The extended pit is floored with timber at four levels, corresponding with those of the original pit, and known respectively as the turbine, the first and second guide-bearing and the thrust-bearing decks. The turbine, or lowest deck, just above the wheels and 130 feet below the surface, is completely floored over, the two guide-bearing decks being simply galleries connecting the platforms about the bearings. The decks are supported on 15-inch 42-pound I-beams resting in turn on cast-iron steps let into the solid rock.

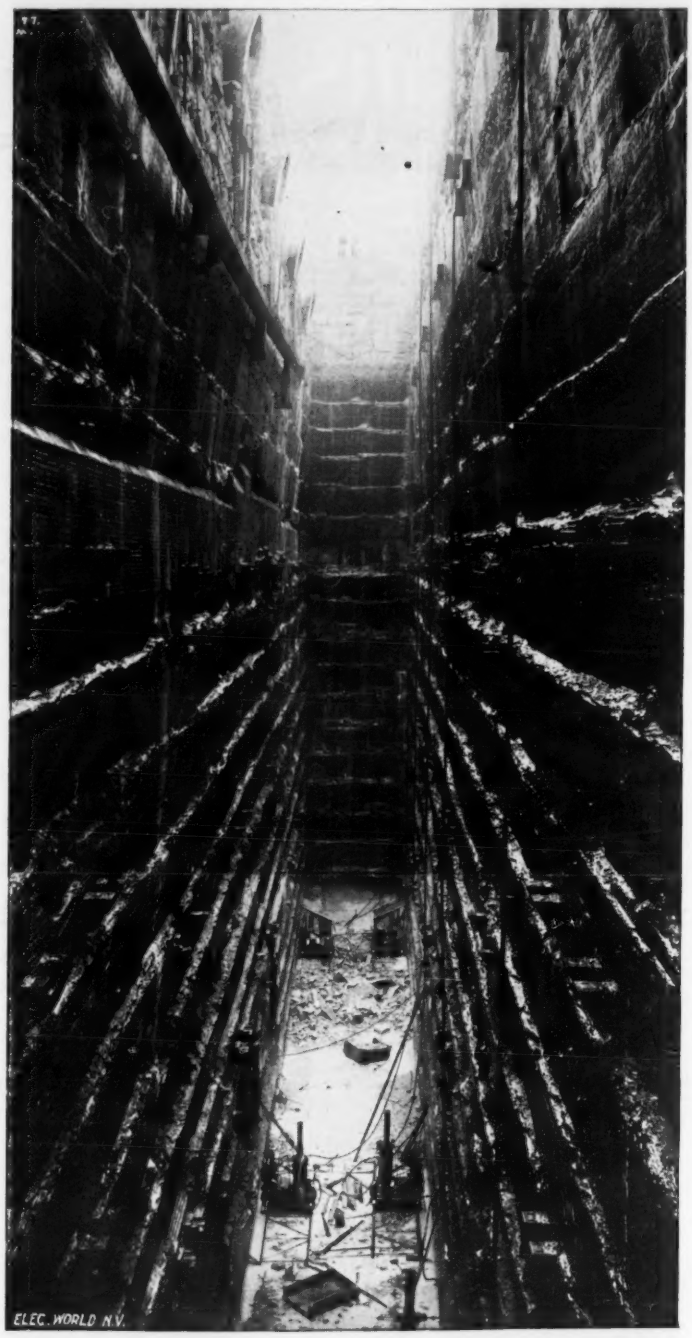


Fig 3.—The Extension of the Wheelpit During Construction.

THE HYDRAULIC PASSAGES.

The original arrangement of the racks through which the water entered from the canal has been entirely replaced, the individual racks across the mouth of each 14-foot intake or forebay giving the water passing through them such a high velocity that it was difficult to keep them clean. These have been removed, and the whole side of the main canal is now one continuous rack, 416 feet in length by 12 feet in height below the water level, with an upward and backward slope, and removable sections that make its cleaning comparatively easy. But little frazil or suspended ice has made its appearance at the racks, not enough to give serious trouble, owing to the fact that the water in the canal is sufficiently still to be largely covered with a sheet of ice which prevents its being chilled throughout by exposure, as is so often the case with long rapids.

The new head gates, 12½ feet high by 14 feet wide, are of the same construction as the old steel sluice gates, and are, like them, raised or lowered by motor-driven screws on the inside line of the power-house wall. The frictional resistance to their motion with a difference of level on the two sides is reduced by sets of rollers which are mounted in frames constrained to move with one-half the velocity of the gate by a two-to-one chain tackle. With the full pressure of an unbalanced 12-foot head on one side one man can raise the gates by hand. Leakage is minimized by rubber packing strips. The great 7½-foot penstocks are also exact copies of their prototypes, except in thickness of metal, one-sixteenth of an inch having been added throughout to give a longer life in spite of rusting.

THE TUI BINES.

The design of the wheels, so far as their power-transforming parts are concerned, has been unchanged, but the cases have been radically altered to give an improved method of support. These and other improvements of the mechanical features described below are the work of Dr. Coleman Sellers, who has devoted during the last few years the best of his time, energy and skill derived from fifty years' experience, to the perfection of this installation. The great shell of the lower elbow of the penstock, which diverts the water into the turbine casing, is in the improved form cast with two wings or lugs which rest upon heavy cast-iron blocks extending through the brick walls into the rock and in turn resting on granite blocks, also passing through the brick walls and cemented into the solid rock. The turbine cases are similarly cast and supported, thus doing away altogether with the built-up steel girders, 6 feet deep, used under the older wheels. A clear idea of this construction may be obtained by an examination of the sectional drawing, Fig. 24, on page 20. As in the old turbines, there are two cast manganese bronze runners or bucket rings, over 6 feet in diameter, one above and one below the inlet, with outward radial flow, with cast-iron guide chutes or distributors immediately within the runners, and ring valves or gates closely surrounding them.

The details of these gates differ somewhat from the original type. They now rise in opening instead of falling, so that should any part of the supporting mechanism give way they will shut the water off in falling instead of turning it on. This also deflects the discharge downward into the tail race instead of upward against the flooring of the turbine deck, as do the old wheels, and at low loads opens the lower orifices between the paddles or buckets, releasing any

small stones that tend to accumulate there. The parallel-motion rocker arms, used to guide the gates of the original wheels and to maintain them concentric with the runners, have been replaced by guides resembling stuffing boxes around both ends of the four vertical guide rods attaching the lower gate to the upper, as is shown in Fig. 26, page 20. The gates surround the runners with a clearance of only one-sixteenth inch, the same close fit being maintained between the runners and the inside distributors, so that accuracy of alignment is quite essential. The gates are supported and lifted and lowered by two vertical connecting rods attached to the two branches of a great Y-shaped lever just above the turbine deck, the common point of the Y being supported by a tie rod from another lever, resembling a walking beam, far above close to the power-house floor. The Y lever down below is fitted with a dash pot, so that should the tie rod break the gates would not fall abruptly and carry away whatever impeded their motion, and give a destructive water hammer in the penstock. There are no relief valves, and the velocity in the penstock is 9 feet per second at full load, so that a sudden closing of the gates would be dangerous.

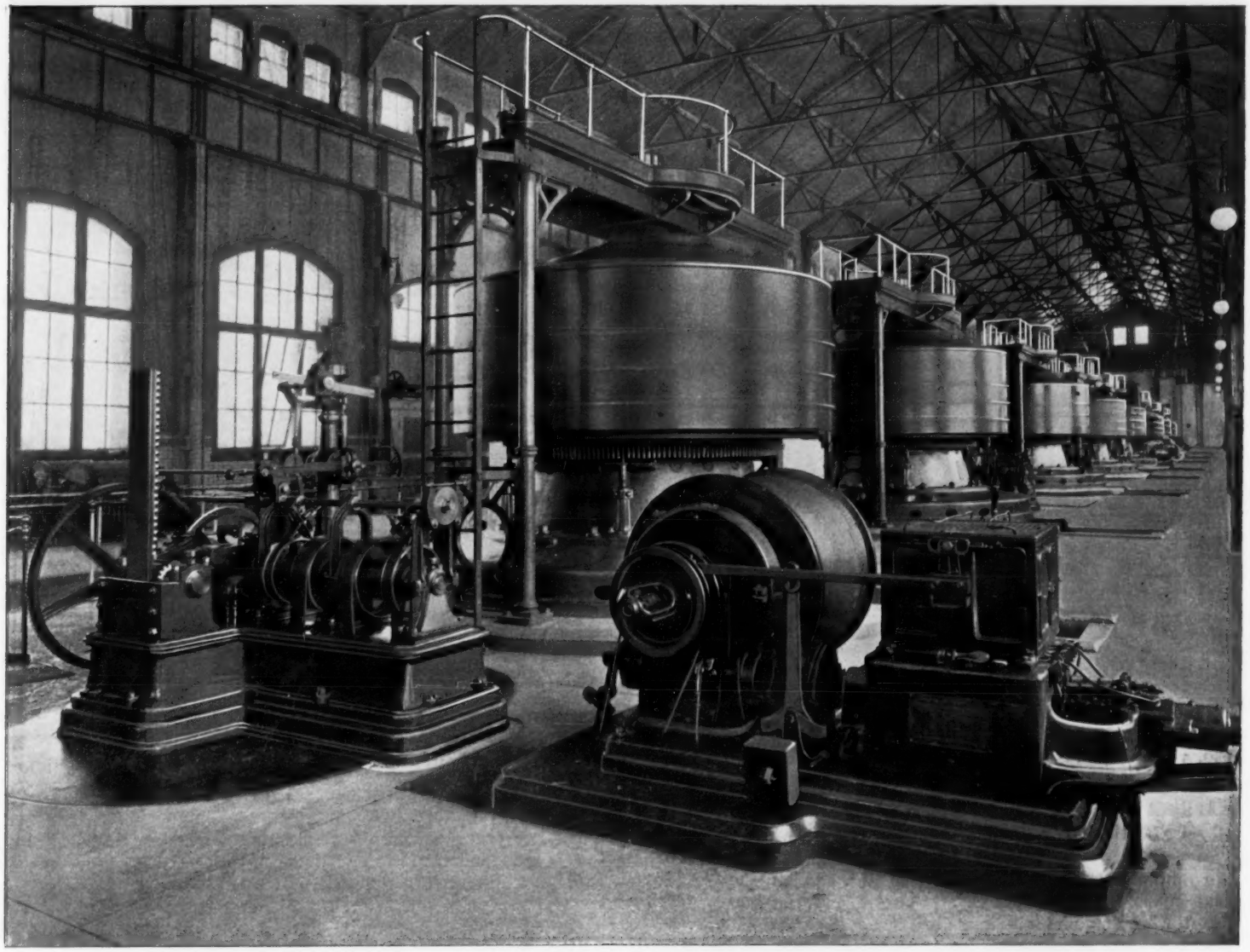


FIG. 4.—A VIEW OF THE MACHINE ROOM WITH OLD GOVERNOR AND OLD ELEVATOR IN FOREGROUND.

Hanging upon the other end of the walking beam above is a counterweight to balance the heavy gates, its location at this elevation being to maintain the connection through the whole height of the wheelpit always in tension, so that no provision for maintaining its alignment is necessary. The governor operates the gates through a rack in turn attached to what is here called the walking beam.

As in the old machines, the weight of the rotating runners, shaft and dynamo field is balanced by the residual, upward thrust of the water against a balance piston consisting of the carrier of the upper bucket ring which receives the full pressure (see Fig. 25), the downward pressure on the lower runner being relieved by the web of the distributors (see Fig. 26). The unbalanced vertical thrust, whether upward or downward, is taken up at a thrust bearing located on the thrust-bearing deck just below the dynamo-room floor, and more fully described below under the oiling arrangements. The new runners, like the old, are cast with two horizontal dividing or partition rings cutting each of the passages between the thirty-two paddles or buckets into three parts vertically, for the purpose of stiffening the paddles and giving high economy at one-third and two-thirds gate opening. One gate is given a greater lead than the others, so that corresponding partition rings in the two turbines are not passed simultaneously.

The long shafts transmitting mechanically the power of the wheels to the dynamos above consist as before of 38-inch tubes of ⅜-inch steel boiler plate narrowing down to short solid sections at the guide journals which maintain their alignment, and to 11½-inch oil-tempered forged hollow nickel-steel dynamo shafts at the upper end. The new wheels were built, as were the old, by the I. P. Morris Company.

THE OILING SYSTEM.

Reaching the deck but a few feet below the dynamo-room floor, these tubular shafts are attached to thrust shafts with collars closely resembling those used with screw propellers and running in babbitted boxes. On account of the great weight of the rotating parts and the variation of the hydraulic thrust with the load, due to penstock friction, whereby the weight cannot be at all times accurately counterbalanced, these thrust bearings must be carefully oiled, and the thrust-bearing deck, therefore, is made the distributing centre of the oiling system. Down one side of the deck, under the arch which supports the floor above, run two sets of oil supply and discharge headers or mains. The pipes of a similar circulating system for the supply of water to cooling passages around the journals and through the armature spider, as described below, run down the other side of the deck. Up under the eaves at each end of the room is a tank from which the oil is fed by gravity to all points where it is needed

from the upper dynamo journals to the lower turbine bearings. There are two duplicate oiling systems, which may be used independently or paralleled.

In a pit under the floor at the east side of the building are two storage tanks capable of holding the contents of an oil tank car, a railroad spur running in immediately over them. From these storage tanks the oil is led down through the strainers of an oil-recuperating system and to the oil pumps which are located in one of four arched chambers branching from the wheelpit at the turbine-deck level 130 feet down. These chambers are each 35 feet long, 16 feet wide and about 14½ feet high to the crown of the arch. The one now utilized for pumping purposes contains the oil-receiving tanks and a duplex direct-acting Worthington pump, closely resembling in appearance a steam pump, but fitted with more ample passages in the valves to allow for the inelastic fluid which drives it, namely, water from the canal. A water-driven direct-acting duplex air compressor stands in the same chamber and gives the air for operating the various pneumatic devices throughout the station. The oil pump lifts against a head of over 165 feet to the tanks way above under the eaves, the oil passing through the oil-recuperating separators each time it makes the circuit. The method of circulating the oil to and from the lower journal of the turbine is ingenious, the violent rush of the water from the runners rendering the use of outside oil pipes inadvisable, and water lubrication being feared owing to the danger of grit. The oil reaches the journal from that above it through a sleeve in which runs the 8¾-inch hollow oil-tempered shaft which connects the two runners, and is discharged into a pan from which it is lifted by suction through a hole in one of the three tie rods or stay bolts which run up diagonally across the wheel case. (See Fig. 26.)

The new intermediate bearings (see Fig. 28) have bronze bushings made in two complete semicircles and lined with babbitt metal with diagonal oil-circulating grooves. The original four-part bearings, in which the parts of the bushing did not form a complete ring around the shaft, were found to heat badly, owing to the churning of the viscous oil. In the new thrust bearings (see Fig. 27) the number of rings has been reduced from ten to seven and the four parts of the bronze liner have been retained, but fitted with removable segments lined with white metal. The total friction is so slight that the small leakage through the ring-valve clearance of one-sixteenth inch keeps the machine turning at about one-sixth speed, and a pneumatically operated strap brake gripping the tubular shaft just below the guide-bearing deck is necessary to stop it.

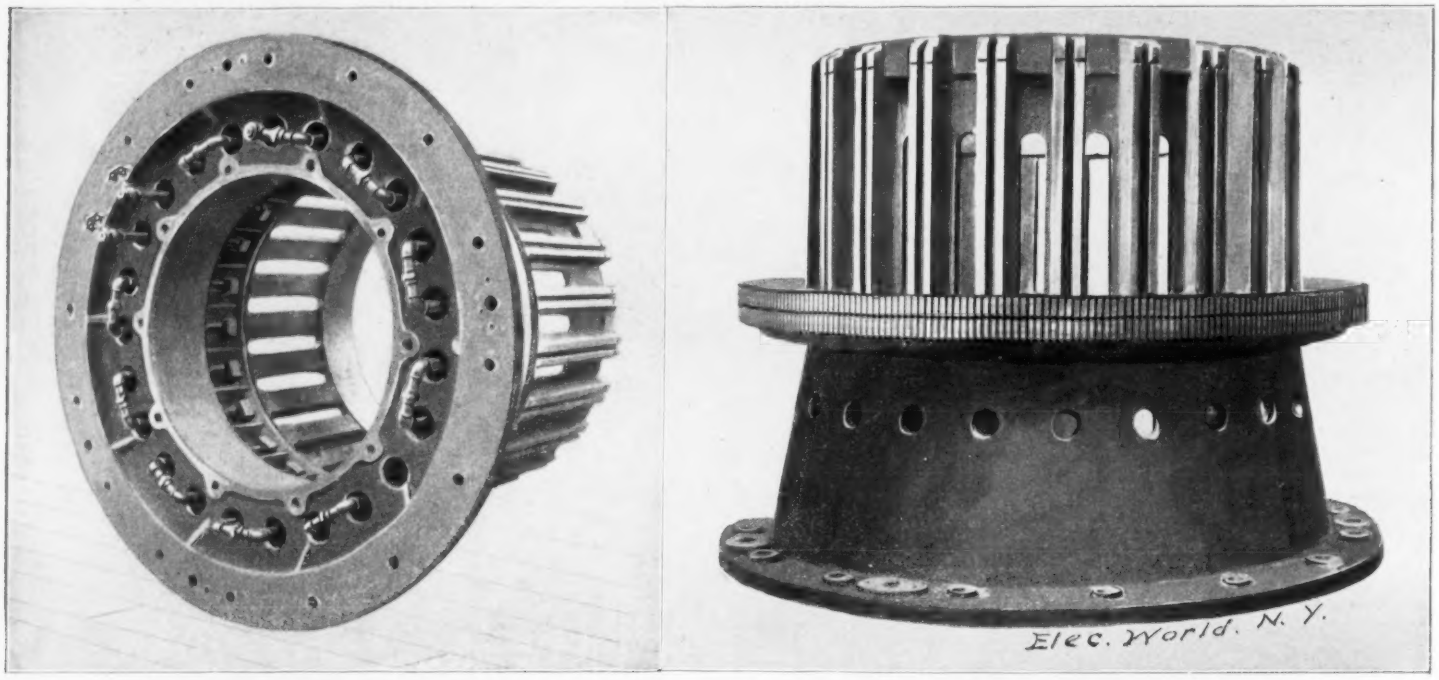


Fig. 5.—The Armature Spider Overturned, Showing Cooling Pipes. Fig. 6.—The Armature Spider with Laminæ Partly Assembled.

THE GOVERNORS.

Coming up above the level of the dynamo-room floor, the machines which have undergone the greatest changes are the governors. It will be remembered by those who have followed the details of this equipment that the original Faesch & Piccard governors are purely mechanical in their action. The gear train operating the vertical rack, which in turn is attached to the gates or ring valves far down below, is driven by the intermediate number of either one or another differential bevel-gear train, one to open and the other to close the gate. The bevel pinions of each of these differential trains are kept in motion by belts from the main source of power, and the third member of each is fitted with a pulley and strap brake. Either one of these brakes may be set by a shaft actuated in turn by a sector-shaped ratchet moved in either one direction or the other by one of two oscillating pawls, the engagement of the pawls with the ratchet being finally effected by the position of the centrifugal fly balls. So long as neither brake is set the main gear train remains motionless, but when either brake is set the intermediate member of that differential bevel train is forced to rotate, carrying with it the mechanism operating the gate.

Dr. Coleman Sellers has made many improvements on this rather complicated and indirect arrangement, the latest development appearing in the governor of machine No. 5, which will be duplicated on all the machines including the original three. In the new type the belt-driven differential bevel trains and strap brakes have been abandoned. The displacement of the revolving balls from normal position moves one or the other of two sets of brushes into electrical contact with a cylinder constantly rotating in an oil bath (see Figs. 7 and 8), and these contacts are respectively connected through collector rings and sliding brushes with the coils of two magnetic clutches, respectively gear driven in opposite directions. The excitation of either of these clutches drives the main train in one direction or the other.

This governor has also several other ingenious modifications. One is the attachment of the cylinder of the fly-ball dash-pot to the gate-operating mechanism, so that whenever the latter starts the cylinder moves with it in such a direction as to tend to force the piston and fly-balls back to the normal position. This gives, so to speak, a restoring force whenever the gate is under way, and tends to prevent over-running, and yet does not diminish the sensitiveness of the governor. The contacts are as usual differentially actuated by the displacement of the weights and the position of the gate, so that there is a 2 per cent. fall of speed between no load and full load, without which, of course, the distribution of the load between alternating-current machines in parallel would not be stable. With this drop there is no "seesawing" of the load between machines.

Still another modification is the use of a device for instantly setting the mechanism in action to close the gate on the opening of the field circuit of the dynamo, this being intended for use in connection with an emergency shut-down system, which is described below. The device consists simply of a heavy weight supported by a solenoid connected in series with the field-magnet winding of the dynamo. When released this weight sets a mechanical clutch so geared as to drive the gate toward the closed position, and at the same time

opens the circuit of the governor contacts so that they cannot set the magnetic clutch for opening the gate.

The operation of these new governors is noticeably different from that of the old. On change of load, the old governors may be seen to "hitch" the gates back and forth in gradually reducing movements until they approach the true position where the torque ap-

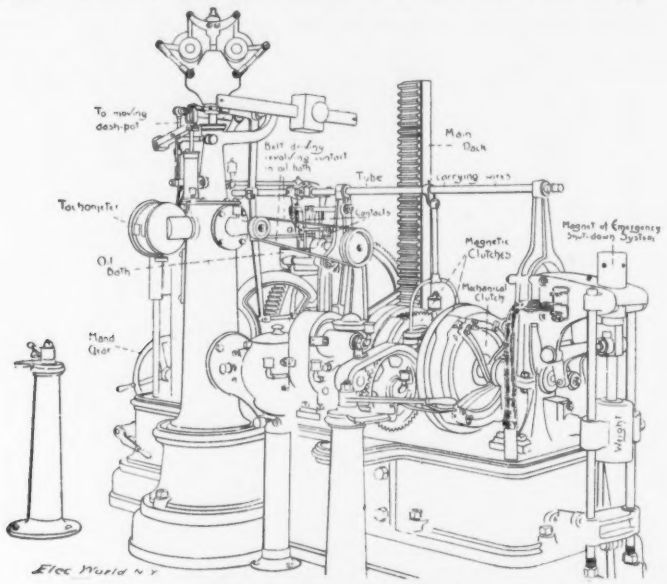


FIG. 7.—KEY TO FIG. 8.

the moving of the dash-pot. The behavior of the old governors is also dependent on the condition of the lubricant on the brake pulleys. No such variable element is present with the new arrangement.

The units may be run two or more in parallel with the governors of one or more up to all but one out of operation, fluctuations in load being taken care of by the one or more governors in service, the load being equalized by an occasional twist of the governor wheels on the part of an attendant. The common practice is to leave one governor more sensitive than the others, which then act only on the greater speed changes. This makes one machine take all the small load variations, the others responding only to the greater variations. The new governor gives a very satisfactory action in case of the sudden removal of the whole load, checking the rise in speed under this condition at about 10 per cent. above normal. The older ones allowed about double this excess.

THE ELECTRICAL GENERATORS.

The dynamos themselves, and the same may be said of the whole of the electrical apparatus, have undergone changes less than those of the hydraulic equipment. The same umbrella-type exterior revolving field, suggested by Prof. George Forbes, is used, making the forged nickel-steel yoke of the field circuit serve also as a flywheel with a peripheral velocity of 9000 feet per minute, a relation of speeds that is justified by the considerations of mechanical strength and electrical losses, and which is now commonly followed in direct-coupled sets. In external appearance the machines differ from their older neighbors only in the sinking of the nuts holding the field poles to the ring into counterbored holes below the surface of the latter. The ring is slightly heavier, some weight saved by the removal of flanges intended to hold a flywheel near

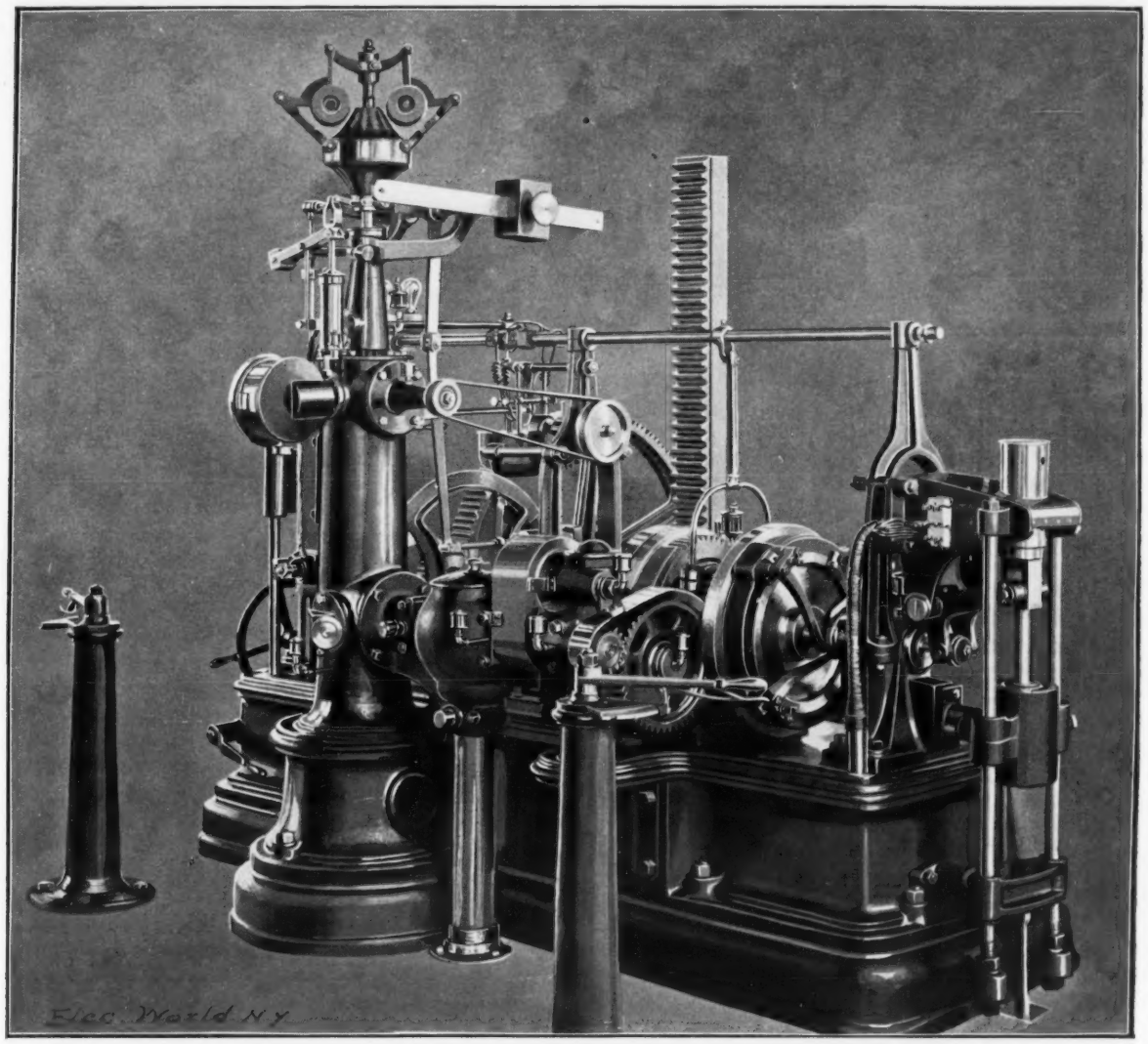


FIG. 8.—ONE OF THE NEW ELECTRO-MECHANICAL GOVERNORS.

plied to the turbine is equal to that of the load. The new governors on change of load move the gates slightly, hesitate and then move them again in the same direction, this difference in action being undoubtedly due to the restoring force applied to the weights by the lower end of the long vertical shaft and by the boring out of the turbine and dynamo shafts having been added to the yoke ring, where it will do double service kinetically and magnetically.

The winding of the inwardly projecting poles has been quite

changed to give a readier dissipation of the ten kilowatts of energy there turned into heat. The conductor is a copper strap one inch by one-eighth inch in cross section, wound edgewise, the corners around the rectangular poles being turned while hot. All fibrous insulation has been abandoned in this part of the machine, the edgewise turns being insulated from each other by mica and shellac. There are four layers of this winding on each pole held apart by mica-covered metal rods with an ample air space for ventilation between layers, but no ventilating ducts between the turns of each layer, the natural tendency of the air being to circulate radially owing to the centrifugal force and to escape from under the edge of the yoke ring, which will maintain a proper circulation in these air spaces. The four layers are substantially boxed in a skeleton brass casting. (See Fig. 10.) All the turns of all the layers of all the fields of one machine are in series, there being thus but one path for the field current, which varies approximately from 50 to 80 amperes in strength, the field resistance being 1½ ohms. The twelve poles themselves are, as in the old machines, steel castings, not laminated, laminations being unnecessary, as the over-hanging teeth and wide air gap prevent tufting of the lines of force. They have extending pole shoes cast to them to increase the effective air-gap area, which is thus approximately made 70 per cent. of the whole armature surface. The horns are tapered back from the gap 11-32 of an inch, in order to properly shape the electromotive-force wave.

The armature itself has been modified in various ways, the most noticeable being the use of twelve one-half-inch ventilating rings instead of the six one-inch, formerly used. The laminæ of No. 29 open-hearth steel are tightly bound together by the modern method of end plates locked to the spider instead of by sixteen great bolts passing through the laminations themselves, as in the old dynamos. The greater accuracy of modern punching machines has obviated the necessity of finishing the slots by a drifting process after the laminæ are assembled. On this account and also because of the removal of the bolts the eddy-current iron losses have been materially reduced.

While high efficiency, as a saving of power, is not of very great importance in machines with power so cheap as it is at the shafts of this installation, it is of great importance in consequence of the coincident reduction of the heating losses. With such mammoth machines, the old battle of the cubes and the squares becomes a serious one, since, roughly speaking, the generating capacity increases in proportion with the cube of the linear dimensions, while the radiating surface increases only in proportion with the square. The iron losses of the new machinery have been estimated by driving them under test by motors and noting the increase in the power absorbed when the fields were excited. The copper loss can be readily calculated and the iron loss under load can be estimated from that obtained by the test described by assuming an increased maximum induction due to load distortion and correcting the hysteresis loss in proportion to the 1.6-power thereof. The iron loss at full load is thus determined at only 32.1 kilowatts, the armature copper loss being 28.7 kilowatts and the field copper loss 7.4 kilowatts, giving an electrical efficiency at full load, 3750-kw output, of over 98 per cent.

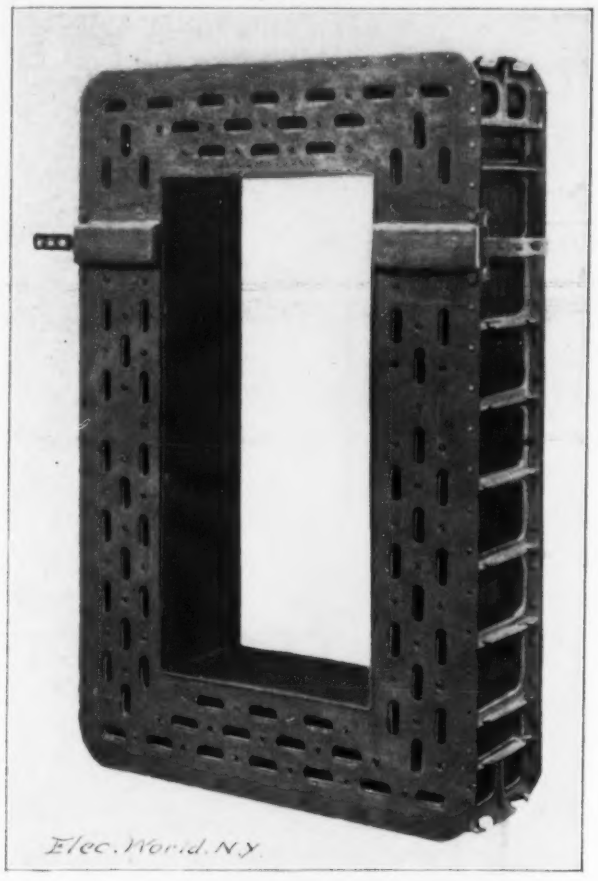


Fig. 10.—One of the Field Exciting Coils.

Fig. 9.—One of the New Machines Under Construction in East Pittsburg.

In the old machines it was expected that there would be a plenum between the open-topped armature ring and the field cover or driver, which would force air outwardly through the ventilating rings betweeen the armature laminæ. This expectation was not realized, the reverse, if anything, being the case. The machines were then fitted with drag hoods or exhaust scoops on the six 14-inch openings of the conical cover or spider driving the field ring. These exhaust some 9000 cubic feet of air per minute, which keeps the machine fairly cool, except for one or two places, notably at the upper end of the armature core, these being further cooled at times of continued heavy loads by flat copper tanks, through which water is circulated. With this provision the maximum rise in the old machines at rated load is about 54 degrees centigrade above the atmospheric temperature.

The new machines, as noted above, have a lower iron loss, more ventilating passages in both armatures and fields, and are also fitted with vertical water-cooling passages cored in the cast-iron spider, into which the armature laminæ are dovetailed. (See Fig. 5.) Without using these, however, and without hoods similar to those mounted on the old machines, it is found that the new ones on continuous run at full open gate reach a limiting temperature only 47 degrees centigrade above that of the atmosphere. This is about a 10 per cent. overload, the rated load of the machine being attained at about nine-tenths gate. Temperature measurements are obtained by so-called exploring coils, consisting of No. 36 copper wire wound on a card in such a way that it can be slipped into narrow passages such as the ventilating ducts. The machine takes about five hours to come to a fixed temperature.

The armature conductors are copper bars two inches by 7-32 inch over all, with rounded corners, mica-insulated and mounted one in each slot, instead of two, as in the first design. The slots, of which there are 322, are almost, but not quite, twice as numerous,

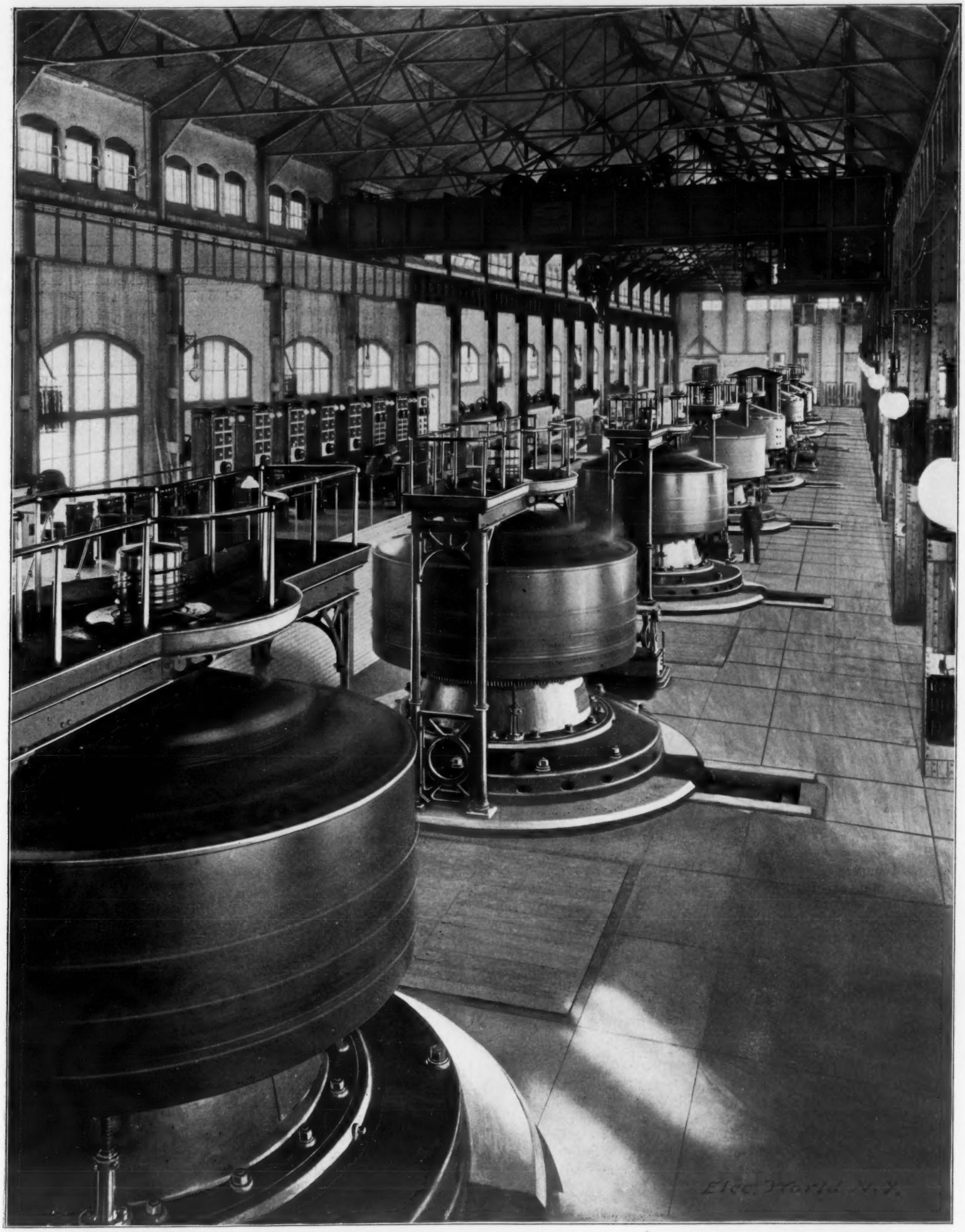


FIG. 11.—A VIEW OF THE DYNAMO ROOM, LOOKING SOUTH FROM THE VISITORS' GALLERY.

as the number of armature turns has been reduced about 15 per cent., the magnetic density being increased in the same proportion. These slots, shown in Fig. 31, page 21, are 13-32 of an inch wide and 2 3-16 inches deep, with rounded corners and overhanging teeth, the opening being 3-16 of an inch in width. The windings of the two phases are electrically independent, distributed thoroughly—the bars being only one inch apart centre to centre—in between thirteen and fourteen slots per pole per phase, and connected up in a wave or series system by the ordinary spiral end-connecting straps. There is but one path for the current per phase, that is, all the conductors of each phase are in series with each other, the rated current density, therefore, being about 1900 amperes per square inch. An improvement in the finish over the old machines is the covering of the riveted and soldered joints between the vertical bars and the lower end-connecting straps by small hard-rubber boxes. The upper end-connections are of course covered in by the revolving field driver and are taped, as are all those of the old machines. The new armatures were wound at the factory of the Westinghouse Electric Manufacturing Company in East Pittsburg before they were shipped, the old ones having been wound in place.

The modern tendency toward close regulation has not been followed in these new machines, which have as high a ratio of armature to field ampere turns as have the first three. The air gap has been shortened from one inch to three-quarters, reducing the field ampere turns by about the same proportion as the armature ampere turns. They require a 50 per cent. increase of the no-load exciting current to maintain the same potential difference between terminals with a non-inductive rated load, and the machine on dead short circuit with full-load excitation only gives about twice full-load current. This is undoubtedly a wise provision in this particular instance. With a battery of such mammoth machines running in parallel with the great momentum of their rotating parts, if they were fitted with powerful fields and were consequently able to give six, eight or more times their rated energy current on short circuit, the conditions in case of such an accident would resemble at the weakest point of the circuit all too closely the detonation of a charge of dynamite. It is almost needless to state that it is impossible to fuse or otherwise break electrically such large powers. It also takes some little while for the field to die down after its circuit is opened. The high armature reaction gives what might be termed an automatic limit which can be depended upon to cut the energy output off at a predetermined point.

With such a high armature reaction the effect of loads and particularly of inductive loads is of course comparatively serious, but with batteries of machines of this size even load changes of 1000 electrical horse-power, which are the maximum that may be expected in regular service, are but a small percentage of the rated capacity of the generators connected, and can be promptly compensated for by the switchboard attendant without any serious change of voltage. The actual regulation obtained is shown by a typical recording voltmeter curve reproduced in Fig. 29. The high armature ampere turns also allow the machines to cross-magnetize each other with but small wattless currents and with a correspondingly small lowering of the power factor and increase of heating in case their field excitations differ somewhat.

For testing these machines there has been erected in the new part of the station a 2,000-volt switchboard with switches fitted with carbon breaks each connected to a resistance of bare iron wire wound on a long, flat, wooden frame much after the fashion of carded cotton. These frames, or ladders, as they are termed, are immersed in one of the forebays about 18x12x8 feet high, and serve to absorb without too violent ebullition in this body of water the load of a 5,000 horse-power generator. With this the machines are tested for reaction, temperature rise, speed regulation, etc.

THE SWITCHBOARDS.

The general scheme of grouping the machines in banks of five, each group indicated and controlled on a separate switchboard, has not only been followed in the additions, but even the details of what is most aptly termed by the English phrase "switch gear" have been preserved. This is the most convincing proof of the study given the original design, as those who have recently worked with large units and high voltages and experienced the trouble incident to handling them can best appreciate. The switchboard galleries show a notable lack of the complicated mess that is to be found on most boards and resemble more the captain's bridge of a great steamer with a few engine-room signals and indicators than the controlling and indicating system of a 40,000-hp plant. This is, of course, in part owing to the concealment of the buses and a large part of the switching apparatus in chambers immediately under the galleries, but nevertheless the system is a remarkably simple one considering the flexibility obtained and the loads handled.

Fig. 12.—A View of the Switchboard Gallery, No. 2.

Each machine is fitted with an instrument panel and in front of it a lever stand, standing separate from the others and practically identical with those of the original installation. The instrument panel contains simply two indicating ammeters, voltmeters and wattmeters, one for each phase, all supplied with derived currents and all of the Niagara type. This type, which was specially designed for this installation and is not very generally used, is peculiar in that the pointer is stationary and the scale movable, instead of the reverse. The scale divisions are marked on a short cylinder, which is revolved about its vertical axis by the deflecting and restoring forces, giving an open scale even with a small instrument, since the scale may make a complete rotation, only a small part of it requiring to be visible at any time. The indication is always straight to the front. Above these six instruments is a small synchronizer, or, as it is intended to be known, synchroscope.

This is simply a voltmeter connected to the secondary of an instrument transformer and notable for the absence of elaborate plugging arrangements for obtaining any desired synchronizer connections. Each synchroscope in series with its secondary winding is simply connected across two buses common to all, each instrument having a key like that of a lamp socket. By simply turning

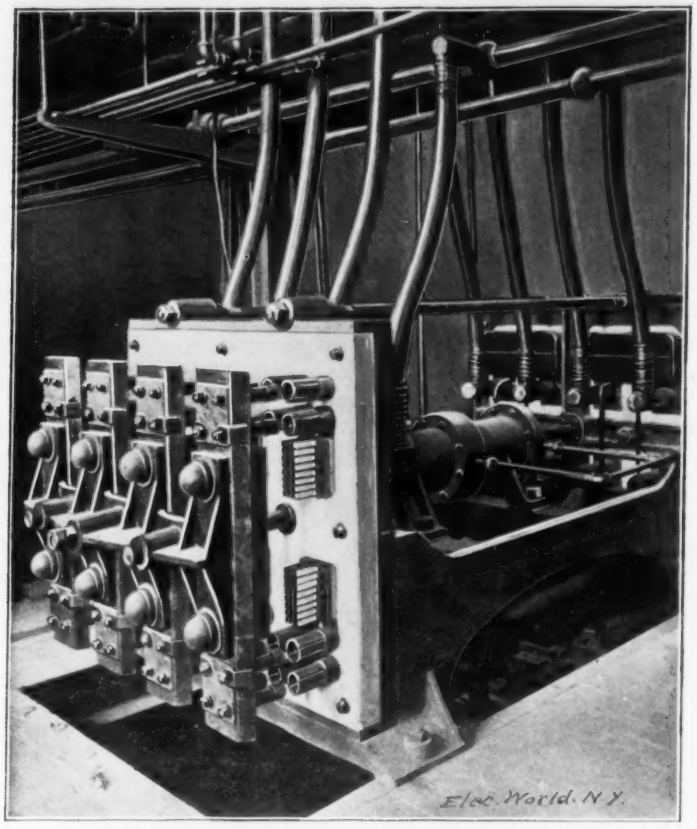


FIG. 13.—ONE OF THE MAIN SWITCHES.

on the synchroscope of the machine to be synchronized and that of any other with which it is desired to synchronize it, the two instruments are put in series with each other in such a way as to act exactly like phasing lamps, only with more accurately determinable indications, showing the attendant the proper time for throwing the machines together. Below the six Niagara-type instruments on each panel is one round-type Weston direct-current ammeter indicating the strength of the exciting current in the field circuit.

The lever stand is surmounted by the ordinary hand wheel controlling the field rheostat and bears also four handles operating air valves directing compressed air to four pneumatically operated switching devices. One is a circuit breaker in the field circuit, a view of which appears in Fig. 14, its chief peculiarity being that it connects across the terminals supplying the field just before opening the circuit—a non-inductive resistance of one ohm. The resistance of the field winding itself being an ohm and a half, and that in series with it perhaps three ohms, the inductive rise of pressure cannot much exceed that generated by the exciters, or 220 volts. Another of the valves controls a throw-over switch in the field circuit, whereby it may be fed from one or the other of the two pairs of exciting buses. The other two valves control respectively two four-pole single-throw switches (shown in Fig. 13) in the main dynamo circuits, two poles for each phase, the two switches connecting respectively with two sets of four-pole bus bars. There are no fuses or circuit breakers in these main circuits, and these switches are intended to break the maximum load which the machines will give on emergency, and will do so, although, of course, they are normally opened only after their respective machines have had their load removed by almost closing the gate and their wattless or magnetizing currents removed by easing down the field excitation to give a voltage at no load equal to that of the other machines loaded, when the switches may be opened with practically no current flowing and with no effect either on the speed of the machine thrown out or on the load or magnetization of the other machines still working. These main switches have primary or low-resistance contacts of the ordinary knife and laminated-spring clip style and secondary breaks—shunted around the main contacts through a resistance of 1,200 ohms per pole—consisting of eight split tubular receptacles and plugs of non-arcing metal. These are so connected up that all eight are in series on each pole, giving sixteen breaks in series in each phase, the maximum opening being about one inch per break and in a horizontal direction. The switches are not latched in any way, stealing motion through air leakage being prevented by the simple process of keeping the air on, each valve having only two positions, one admitting in front of the switch piston and the other behind it. There are no feeder boosters, phase regulators or other boosting or regulating devices connected with the system, any lines requiring a voltage different from that of the rest of the load being isolated on exclusive machines. The system is now commonly run with two batteries, one supplying local loads and the other, at a higher pressure, the long-distance line to Buffalo, Tonawanda and Lockport.

A modification not contemplated in the original plan, but which has been added to all eight machines, is the provision of emergency shut-down stands, one on each of the two switchboards. These shut the machines down not by opening the main circuits but by opening the fields by means of the field circuit breakers, which can not only be unlatched by the air cylinders and valves mentioned above, but also by a regular trigger and magnetic trip with a shunt coil operated from these shut-down stands. The latter consist essentially of two rows each of five plug switches, each machine being represented by a switch in each row. Beside these is a double-pole double-throw knife switch which, closed in either position, throws current on to the circuit-breaker trip coils of all machines plugged in the corresponding way. Under normal conditions all the machines connected to one set of buses will be plugged in one row, and those connected with the other buses in the other row. In case there is serious trouble with the circuits branching from either set of buses, all that will be necessary to shut off the power from them will be a movement of the switch in the proper direction. This will open all the circuit breakers of the machines feeding that set of buses and simultaneously set the governors in action and close the gates of the corresponding turbines, thus rendering dead that system of lines. The handling of these great machines with these few instruments and air valves is most perfect.

The procedure of starting a new machine to aid those already running when the load rises above their capacity is somewhat as follows: The gate-lifting mechanism is gradually opened up by hand, the machine rapidly picking up its speed until the tachometer mounted on the governor shows the proper indication of 250 r. p. m. The switchboard attendant then closes the field circuit breaker and the field switch on the live exciter bus bars and builds

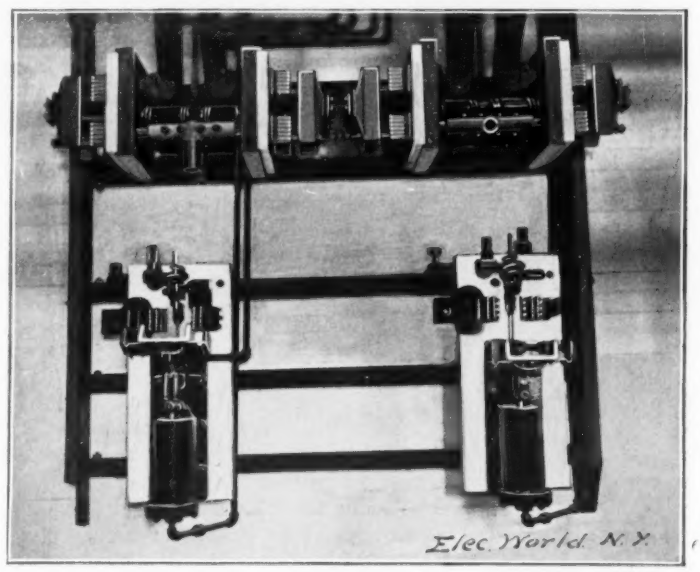


FIG. 14.—TWO EXCITER CIRCUIT BREAKERS AND SWITCHES.

up the voltage by cutting out the field rheostat until he gets the proper indication on the two Niagara-type voltmeters. The keys of the synchroscope of the new machine and of another attached to a machine already in service are then closed, the needles of the

two synchroscopes beating together at a rate proportional to the difference in speed between the battery in service and the fresh machine. A few hand and arm signals direct the governor attendant to admit more or less water to the turbine, and soon the needles slow down, and finally approach very slowly the zero scale position. A twist of the main switch valve, and the dynamo is in.

The transfer to the new machine of its proportion of the Titanic load, which it shoulders without audible sign or apparent effort, is an awe-inspiring sight. There is no visible evidence of the shifting of the thousands of horse-power other than the steady procession of hundred-kilowatt and hundred-ampere scale division past the instrument pointers and the steady rise of the gate-lifting rack of the new machine foot by foot, accompanied by the simultaneous fall of the others in the battery. The magnetic reaction of the load is easily taken up by steadily increasing the field-exciting current until the direct-current ammeter shows the same indication as that of the others. Owing to the strong armature reaction the machines hold each other in synchronism without heavy cross-magnetizing currents and balance each other's voltages automatically without close adjustment of the field excitation.

THE EXCITERS.

In the original installation current for exciting purposes was derived from any one or more of three sources. First, an engine-driven dynamo in the neighboring steam-driven plant of the Niagara Falls Waterworks, and normally from either one or both of two 200-kw rotary converters, deriving their power from the alternators which they excite, the pressure of the exciting circuits being 220 volts. In order to avoid dependence on an outside source of current, should the whole installation shut down for any emergency, and to give an exciting pressure less dependent on the machine voltage and speed, turbine-driven exciters have been installed with the new apparatus. Grouped in the corners of a square about the new hydraulic passenger elevator leading down into the wheelpit, and between machines five and six, there are four of these Westinghouse four-pole exciters (see Fig. 18) resembling others of the same make in most particulars except that their shafts stand upright, the armature being overhung on the upper end of the shaft. Like those of the big alternators they excite, the upper journal is carried right up inside the armature, which is mounted on a long hollow cone to permit this. Thus, any unbalanced magnetic pull or lack of static balance in the rotating part is taken up without any serious bending moment in the shaft as would exist were the journal below the armature. The commutator is of course on top, rendering easy its inspection and care.

The four machines are fitted with two exciter panels and instrument stands, one on each switchboard, with a voltmeter and ammeter each, and pneumatic throw-over switches and circuit breakers to cut them in circuit with either one of the two sets of bus bars. Each of these machines is direct coupled to a turbine made by the S. Morgan Smith Company, with a single radial inward-flow runner mounted some fifteen feet above the main wheels so as to bring them clear of the turbine deck. The speed of the exciters will be governed by hand through a pair of buttons, a magnetically-operated valve and an hydraulic ram attached to the gate. Each of them has its own penstock branching from a common intake and head gate above. The running of the exciter circuits at 220 volts gives a large margin above the needed field excitation. The resistance of each main field being only one and one-half ohms, with the eighty amperes, which is about the highest exciting current, the drop in the field rheostats, which are made of a large number of Westinghouse railway-controller resistances, is about 100 volts, amounting to about eight kilowatts per machine. This series resistance reduces the time constant of the field circuit and thereby renders the response to changes of the resistances more prompt, and gives a wide margin to cover the demagnetizing effects of heavily reactive loads.

Fig. 15.—A Bank of 935-kw Transformers, Four of Which Carry the Load of One 5000-hp Generator.

THE LINES AND TRANSFORMERS.

The new machines are connected with their boards through vitrified ducts laid under the cement floor, instead of through small subways, as were the old. A similar change has been adopted throughout the property of the company, the lines to the structures of the various tenants being now drawn into Camp conduits, instead of being run through tunnels, as was originally intended under the proposals of Prof. George Forbes. The latter also

contemplated the use on all the local lines of 20,000 volts generated direct in the machines, instead of which the comparatively low machine voltage adopted is taken directly to the tenants' transformers. The feeders are tapped off from the bus bars through pneumatic switches—which resemble the main machine switches—with lever

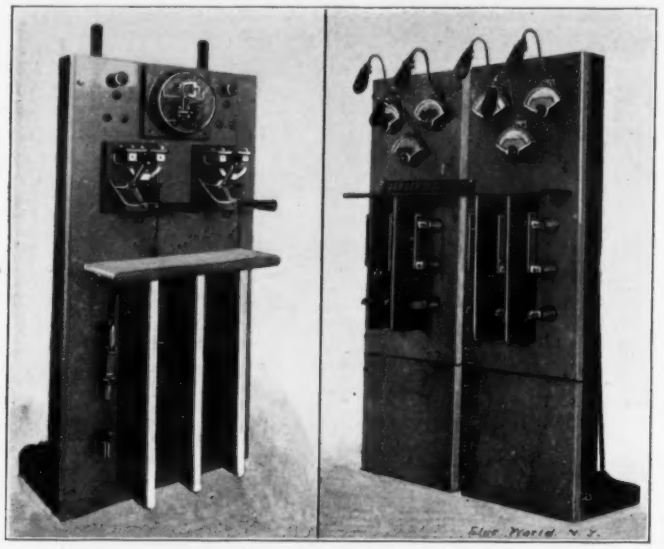


FIG. 16.—ONE OF THE 2200-VOLT PANELS IN THE TRANSFORMER ROOM.

FIG. 17.—ONE OF THE 22,000-VOLT PANELS IN THE TRANSFORMER ROOM.

stands on the galleries. Eight feeder lever stands have been constructed on the new switchboard beside the lever and instrument stands for the cross-connecting switches between the four buses on the two boards. The latter are fitted with centre-zero indicating wattmeters to show which set of buses is taking more than its share of the load. The new feeders have not been fused as were the old, the unreliability of fuses in these large powers rendering them more of a nuisance than an aid. The feeders run out through the subway or wire tunnel to the transformer house, where those carrying power for Buffalo and other distant cities enter the step-up transformers, the others being jointed here with the lead-covered cables drawn into the ducts of the conduits.

The transformer house now contains ten General Electric air-insulated and air-cooled 935-kw transformers, the largest ever

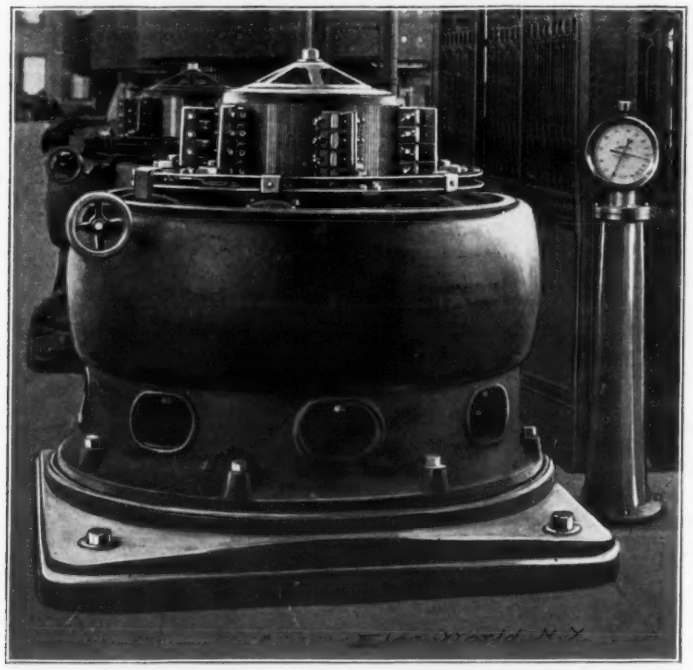


FIG. 18.—THE NEW WHEEL-DRIVEN EXCITERS.

built, stepping the voltage up to 11,000, the high-tension coils being arranged in two parts in multiple, which may be thrown over to series, which connection will give 22,000 volts, and will be made when the load on the line warrants the quadrupling of its capacity by this means. The present ohmic drop to Buffalo with all six wires in is only about 5 per cent. The transformers also change the phase relation, giving three phases for the line by the grouping of the windings after the manner devised by Mr. Charles F. Scott.

The transformers are fitted with high and low tension panels, the latter having quick-break switches with barriers and a new and interesting form of circuit breaker, with a time element. This consists essentially of a General Electric breaker of the ordinary railway type with the secondary break and blowout coil removed, the trip coil being wound not with the main circuit, but with a fine winding, controlled by a contact in a clockwork mounted on the face of the board, as shown in the illustration (Fig. 16). The magnet in the main circuit actuates a detent which releases the clockwork, which may be set to make the contact and trip the breaker at any interval varying from a fraction of a second up to ten seconds or more. The intent is to install two or more of these on each line, those furthest from the power house being set to let go quicker than the others. On the power circuit feeding the Lockport road at Tonawanda, for example, there would be placed at the latter point a breaker set to open in two sections, that in the

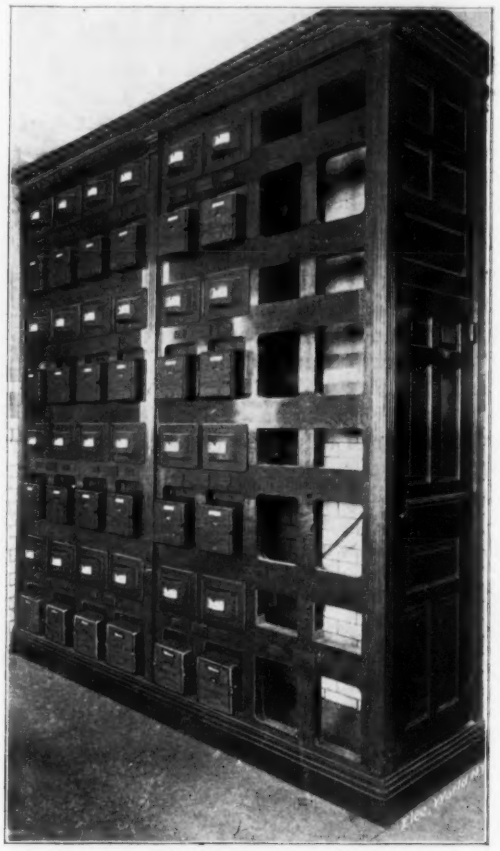


FIG. 19.—THE BANK OF INSTRUMENTS BESIDE MR. LINCOLN'S DESK.

power station being set for three. Although an overload or short circuit starts the clocks of all breakers on that line, the removal of the load by the first breaker opening stops the motion of the others and automatically restores them to their normal position. The breakers themselves are shunted through long fine fuses, which will momentarily take the current when the circuit opens, preventing the formation of an arc at the breaker contacts and blowing out with such violence that the maintenance of an arc between the fuse terminals will be prevented. These fuses are mounted in plugs, the heads of which may be seen near the top of the panel shown. They blow out through chimneys, which may be seen rising from behind the board in the same illustration. The high-tension switches on the panels shown in Fig. 17 are all of the type generally put out by the General Electric Company for this service, mounted on corrugated hard-rubber bases and manipulated by a long stick, a hook on which engages in a hole in the end of the switch blade. The switches are carefully isolated from each other in stalls separated by barriers. They are not intended to be opened under load, but only after the low-tension circuit has been opened, thus in any instance never getting more than the magnetizing current of the transformers and the capacity current of the line.

LOADS.

The total load on the station now runs up to about 15,000 kilowatts, the daily load curve being remarkably smooth, whatever variations there are in it being due to the Buffalo load. The local load, consisting mainly of furnaces and electrolytic plants, is ideal in its regularity, the local load curve for December 28, 1898, for example, varying between 11,700 kilowatts as a maximum and 11,500 as a minimum. For the same day the Buffalo load varied between a maximum of 3140 and a minimum of 500 kilowatts, with an average of 1668. The power factor of the whole load averages about 95 per cent. The load is rapidly growing, superposed load curves for the same date for the past three years, shown in Fig. 30, showing a greater growth during the last year than during the previous one, and the contracts for power indicate that the same increased increase will occur next year.

Of the various tenants, as those using the property or power are called, only one makes use of the canal and tunnel privileges on its own wheels. This is the Niagara Falls Paper Company, which utilizes now about 8000 horse-power.

In a row extending northward from the power house along the river front are the tenants using electric power. The first of these is the Carborundum Company, which now has transforming apparatus and furnaces in for the use of 2000 electrical horse-power. The regulating devices recently installed in this plant are of great interest and are described in an article by Mr. J. S. Peck, beginning on page 16. Next to the Carborundum plant are the upper works of the Pittsburg Reduction Company. These absorb some 3000 electrical horse-power at 160 volts direct current. The same company has other works called the lower works near the power plant of the Niagara Falls Hydraulic Power and Manufacturing Company, from which it takes another 3000 elctrical horse-power. Next to this plant is that of the Union Carbide Company, the demand for whose product is increasing so rapidly that it has lately contracted for 15,000 additional horse-power for another plant to be erected on the Niagara property, besides its great projected plants at Massena and at Sault Ste. Marie.

Next to this are the works of the Mathieson Alkali Company. The transformer room of this plant, as shown in Figs. 20 and 21, is of considerable interest. There are here eleven rotaries rated at 126 kilowatts, each delivering 225 volts. Each rotary is fitted with a regulator and switchboard panel and two stationary transformers. The panel shown in Fig. 20 has a direct-current voltmeter and ammeter, an alternating-current ammeter, a field rheostat, four fuses in the four incoming alternating terminals, a plunger-type switch and a regulator consisting of a wheel pilot which cuts in more or less turns in the transformer windings, thus varying the impressed alternating-current electromotive force on the rotaries.* Beyond this plant come those of the Niagara Electro-Chemical Company, the Lead Reduction Company and the Oldbury Chemical Company, Limited. Other local loads on the same station are the power house of the Niagara Falls Electric Light and Power Company, which is equipped with two 400-hp induction motors; the local street railways and the Buffalo and Niagara Falls line.

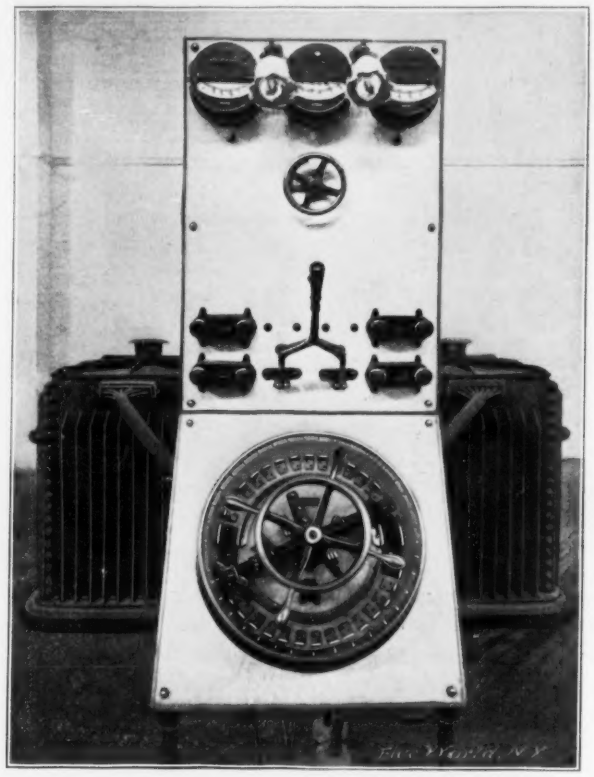


Fig. 20.—One of the Controlling Panels of the Converters, Mathieson Alkali Works.

The current transformed up to 11,000 volts is taken to Buffalo, Tonawanda and Lockport. The installations in Buffalo will be described in these columns. In Lockport there is in service a

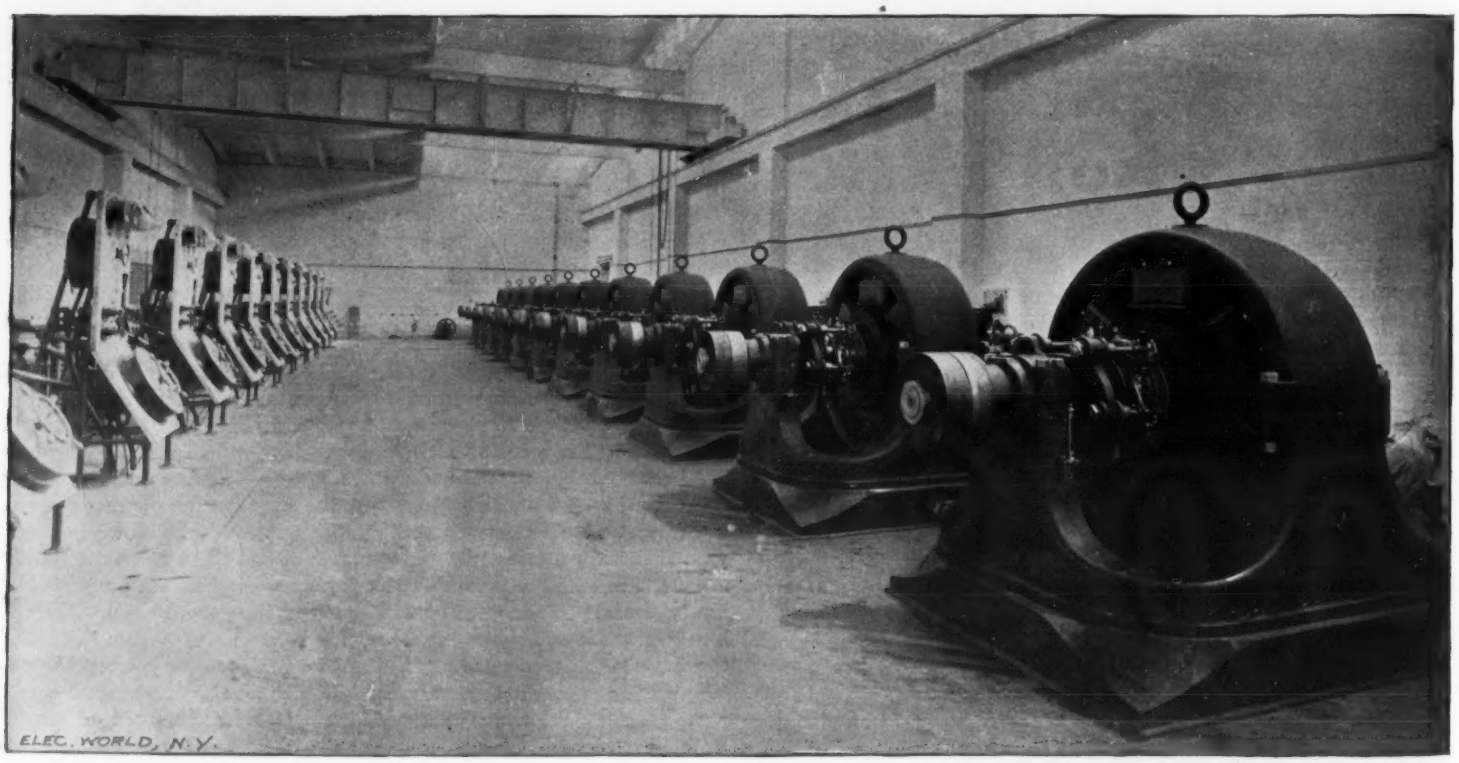


Fig. 21.—A Row of Rotaries Feeding the Mathieson Alkali Works.

*For a fuller description of this plant see The Electrical World of November 27, 1897, page 637.

rotary converter sub-station, taking current from a line of three 0000 bare copper wires branched from the Niagara Falls-Buffalo line, stepping it down to 350 volts in six 150-kw transformers and transforming it to direct current in two 400-kw 500-r. p. m. rotary converters.

A new station is just being finished in Tonawanda equipped with

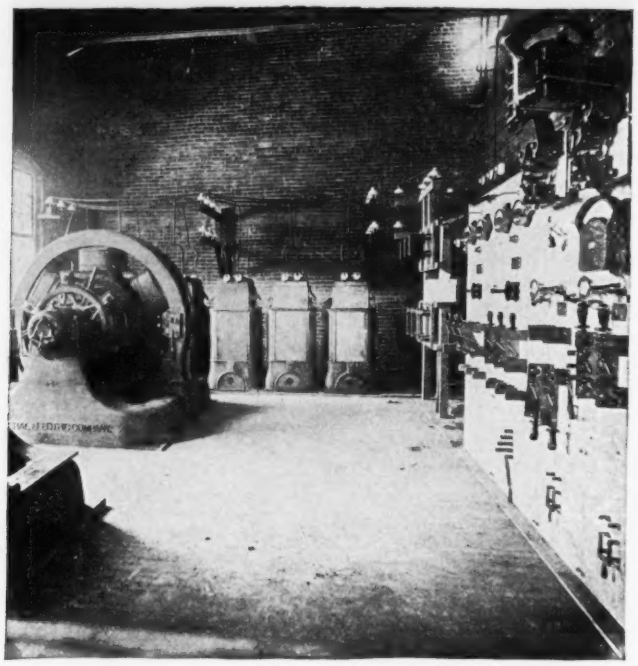


FIG. 22.—INTERIOR OF SUB-STATION AT LOCKPORT.

four 500-kw transformers of the forced-draft type, three of which are delta-connected across the lines and one is held in reserve. These transformers have two secondaries, one designed to give 370 volts for the converters and the other 4400 volts for distribution to other loads. The transformers can give one-half their rated load to one and one-half to the other secondary, or, in case either secondary is open, 60 per cent. of their rated output to the one in service. The railway load will be further transformed by means of two 375-kw rotaries carrying adjacent sections of the Buffalo and Niagara Falls line and the line from Tonawanda toward Lockport.

THE ENGINEERS IN CHARGE OF THE WORK.

The present organization of the engineering force of the Cataract Construction Company, which has charge of all construction work, under the general supervision and direction of Dr. Coleman Sellers, comprises a resident engineer, Mr. W. A. Brackenridge; an electrical director, Mr. L. B. Stillwell, and several assistants.

As resident engineer Mr. Brackenridge is in charge of all work of construction other than electrical construction, and as resident engineer of the Niagara Falls Power Company he is in charge of all engineering work of that company other than electrical. He is ably assisted in his work for the Cataract Construction Company by Mr. A. H. Van Cleve, assistant engineer, and Mr. D. P. Jones, assistant engineer.

As electrical director Mr. L. B. Stillwell is in personal charge of all the electrical interests of the associated companies. In supervising the operation of the plant of the Niagara Falls Power Company he is assisted by Mr. P. M. Lincoln, electrical superintendent, and Mr. Philip P. Barton, assistant electrical superintendent.

CONCLUSION.

No better proof of the success of the original installation from a mechanical and electrical standpoint can be offered than the absence of any important changes in the recent additions. These have been made, as the above description shows, with only detail modifications, not for the purpose of rendering the whole installation uniform but solely because the original general plan was found to be the best one. A consideration of the state of the art at the time the main features of the original plant were settled, namely, 1890 and 1891, will show the remarkable foresight of the members of the original commision. Multiphase work was absolutely unknown in this country; the only alternating-current apparatus consisted of small single-phase belted machines, never run in parallel and never running motors. There were no records of experience from which to draw conclusions as to the relative merits of two-phase or three-phase systems, as to the proper frequency within limits of 10 to 100 cycles per second; there was no available data on the difficulties to be anticipated with high voltages other than that of the Lauffen-Frankfurt test transmission which carried, comparatively speaking, a very small amount of power and that with considerable trouble. The size of the units adopted was far greater than anything ever before attempted. The type was absolutely new, the peripheral speed was extremely high, the weight of the rotating parts was many times greater than that of any machinery previously built on vertical shafts, and the speed of rotation was high. The daring nature of the undertaking was only equaled by the care with which the best expert advice to be obtained the world over was considered and made use of. One remarkable feature of the plant as a whole is the fact that the changes in the electrical equipment have been, as a rule, far less than those of the hydraulic, and in the two new machines which will soon be contracted for there will be absolutely no changes from the last five, while the new turbines will be subject to several modifications.

A Simple Means of Obtaining a High Vacuum.

The use of liquid hydrogen has been proposed by Professor Dewar for the production of very high vacuo. If the end of a closed tube containing air is immersed in liquid hydrogen, the contents of the tube are quickly condensed to solid air, and if the portion of the tube from which the air has thus been removed is sealed with a blowpipe, a vacuum is obtained so high that it will scarcely allow an electric discharge to pass. This condensation is accomplished almost instantly, the required time of immersion never being more than a minute. This gives a simple means of obtaining the high vacuum necessary in Crookes tubes, and might possibly be on a large scale sufficiently economical for use in incandescent lamp works.

Automobile Ice Wagons.

It is stated that the Consolidated Ice Co., New York, which serves Manhattan and Brooklyn with ice, is desirous of applying some system of propulsion to its one thousand ice wagons. The weight of the empty wagons is about 3500 pounds, and they carry loads of ice varying from 6 to 8 tons. The city routes average from 10 to 15 miles a day, and the suburban routes 20 to 25 miles. It is

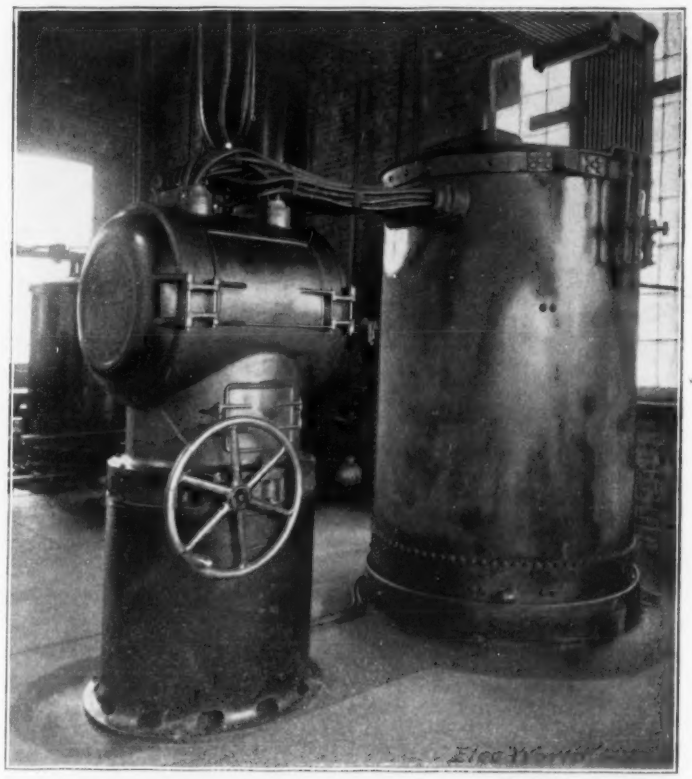


FIG. 23.—IN THE TRANSFORMER ROOM OF THE CARBORUNDUM PLANT.

pointed out that the motive power selected must necessarily be free from heat and smell, since ice absorbs odors and would be melted by the heat. The officials of the company solicit correspondence on the subject from inventors and manufacturers.

The New Transformer Equipment of the Carborundum Company at Niagara Falls.

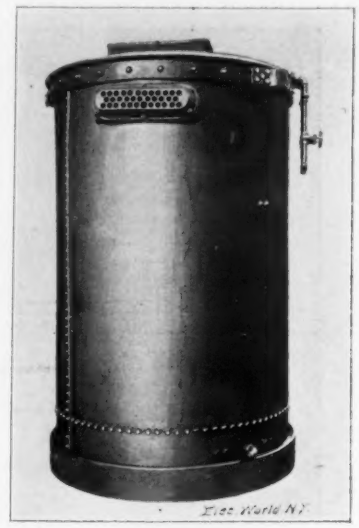
BY J. S. PECK.

THER things being equal, the value of any substance as an abrasive depends upon its hardness. The diamond, the hardest known substance, would therefore be the most valuable for this purpose did not its scarcity and excessive cost preclude its use. Fortunately, however, a substance has been invented which, while falling but little below the diamond in hardness, may be obtained in large quantities and at reasonable cost. This substance, known as carborundum, is being manufactured in large quantities, by a process invented by Mr. E. G. Acheson, at the works of the Carborundum Company at Niagara Falls.

Carborundum is a chemical combination of carbon and silicon formed by heating to an extremely high temperature coke and sand, mixed with small quantities of sawdust and salt. Electricity being the source of the heat, the process is an electrical one, although no electrolytic action takes place.

The furnace in which carborundum is made consists of nothing more than a rectangular bin, the sides of which are built up loosely of fire brick, and are pulled down after each heat. The ends are also of brick, but are of more solid construction, and contain the carbon and copper terminals, to which are attached the conductors for conveying current to the furnaces. Each furnace is approximately 17 feet long, 6 feet wide and 6 feet high. The process of manufacture is briefly as follows: The side walls of the furnace are first built up, then the mixture, consisting of finely granulated coke, mixed with the proper proportions of sand, sawdust and salt, is thrown in, until the furnace is about two-thirds full; at this point a trough, reaching from end to end of the furnace, is scooped in until the furnace is piled high with it; then the conductors for supplying the alternating current are connected, and the furnace is ready for starting.

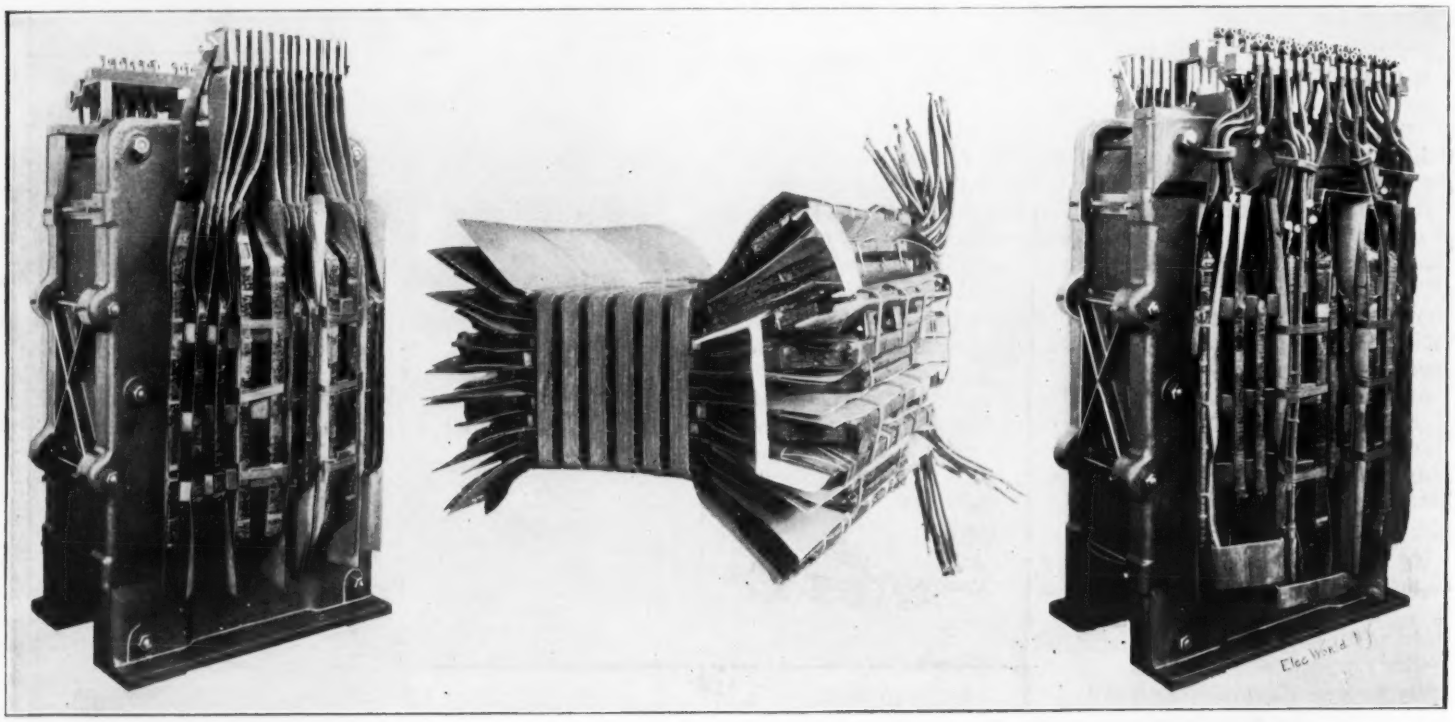
In order that the proper current may be supplied at all times during the process it is necessary that the voltage impressed on the terminals of the furnace be capable of an adjustment from approximately 80 to 200 volts, depending upon the characteristics of the core and the temperature of the furnace. At starting, when the furnace is cold, the resistance of the core is high, and a high e. m. f. is required; as the furnace heats up the resistance falls, and the voltage must be lowered accordingly. This adjustment of the voltage is necessary, as it is required to hold the temperature of the furnace as nearly constant as possible, which necessitates a constant electrical input. So essential is a uniform supply of heat to the high efficiency of the process that the ordinary methods of regulation, which consist in cutting in or out turns in primary or secondary of the transformer, were prohibited, and only such methods allowed as would permit a perfectly gradual variation with no sudden jumps in e. m. f.



As the current is supplied at the power house of the Carborundum Company at a pressure of 2200 volts, a transformer is required for reducing and a regulator for controlling the voltage before current can be supplied to the furnaces.

For several years the Carborundum Company has had in operation a plant installed by the General Electric Company, consisting of an 830-kw transformer and a 600-kw regulator. The business of the Carborundum Company has, however, grown so rapidly that it has been forced to double the capacity of the plant, and a second transformer and regulator have recently been installed by the Westinghouse Electric & Manufacturing Company.

As the original plant has previously been fully described, only such description of it will be given here as is necessary to bring out more clearly the differences between the old and new installations.



Transformer, Showing Method of Bringing Out Secondary Terminals.

Coils Assembled and Insulated.

Transformer, Showing Loops and Primary Terminals.

The method of regulation employed in the original plant is shown by Diagram I., Page 17. The primary of the reducing

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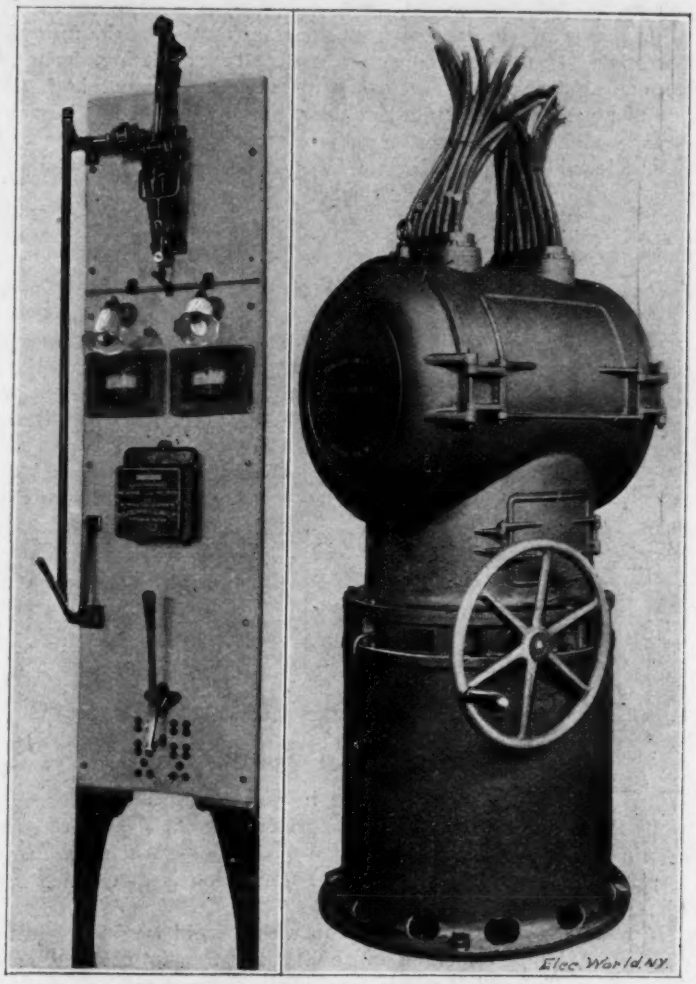
transformer is connected directly across the 2200-volt circuit. The secondary is connected in series with the secondary of a regulator, whose primary is connected to the secondary terminals of the transformer. The regulator is simply a transformer in which the relative positions of primary and secondary windings may be so changed that from a position where the whole flux generated by the primary cuts the secondary effectively and consequently where the secondary voltage is a maximum, the positions may be gradually changed to a point where the primary flux has no effect upon the secondary, and therefore when the secondary voltage is zero. If the movement is continued past the zero point the secondary voltage will begin to increase, but in a reverse direction, until it again reaches a maximum. Since the secondary of the regulator is in series with the secondary of the transformer, its voltage will be added to or subtracted from that of the transformer, as the case may be, so that the voltage on the furnace may be varied from the sum of transformer and regulator voltage to the difference between the two. The variation is gradual, and no sudden fluctuations are possible.

The disadvantage in this system of regulation lies in the excessive capacity required in the induction regulator. The ratio of the



THE HIGH-TENSION SWITCHBOARD. THE REGULATOR.

transformer is 2200 to 185, and that of the regulator 185 to 75; there may thus be delivered to the furnace an e. m. f. varying from 110 to 260 volts. The output of the transformer is 830 kilowatts. The current will therefore vary from 7545 amperes at 110 volts to 3192 amperes at 260 volts. At the lowest voltage the regulator must therefore be able to deliver 7545 amperes at 75 volts or 565 kilowatts.

An induction regulator of this size is an expensive piece of apparatus to build, is difficult to keep cool, and its power factor is apt to be so low as to seriously affect the regulation of the generator from which it is supplied. In order to reduce the size of regulator required, where the above method of regulation is employed, the Westinghouse Company has developed a new method of regulation, and has adopted it in the new plant recently installed.

When it is desired to obtain a variable secondary voltage from a transformer whose primary is supplied with a constant voltage, the simplest method is to bring out loops from the primary or secondary windings, and by means of these loops change the ratio of primary to secondary turns; this method of regulation is, however, only permissible when small jumps in voltage are not objectionable, and therefore could not be used in this particular plant.

It was, however, suggested by Mr. Norman Rowe, of the Westinghouse Company, that a combination of the "loop" and "induction" methods might be effected with very considerable advantage. This method of regulation consists in bringing out loops from the primary of the transformer and of using an induction regulator for stepping from loop to loop on the winding.

In Diagram II. are shown the connections of transformer and regulator where this method is employed. *A*, *B*, *C*, *D*, *E*, etc., are loops brought out at equal intervals from the primary of the transformer. The primary of the regulator is connected across the secondary terminals of the transformer, while the secondary is in series with the primary of the transformer, as indicated in diagram. Diagram III. shows the change in the secondary voltage of the regulator as it is rotated. Suppose the regulator to be in position 1, so that it is generating its maximum e. m. f., and in a direction opposing that of the primary circuit; then the terminal *Y*, being connected to the loop *A*, it is evident that the secondary voltage of the transformer will have its minimum value, for all primary turns are in circuit, and the regulator voltage opposes that of the line. If the regulator be now rotated its secondary voltage will begin to decrease and the secondary voltage of the transformer to increase, until position 2 has been reached, where the regulator voltage, being zero, has no effect on the voltage of the circuit. As the rotation of the regulator is continued its voltage will begin to

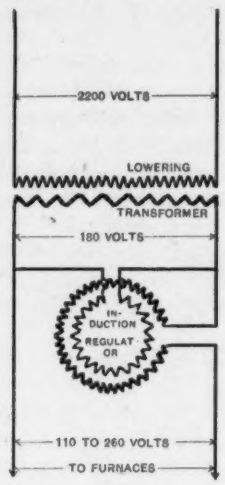


DIAGRAM I.

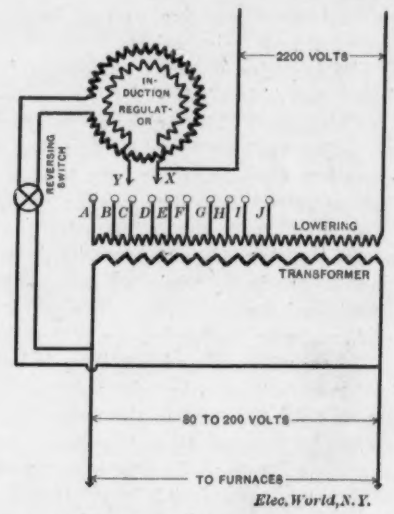


DIAGRAM II.

increase, adding itself to that of the line and increasing the voltage of the transformer. When position 3 has been reached the voltage from *X* to *Y* is exactly equal to the voltage from *A* to *B* (this being the ratio for which the regulator is wound), and *X* and *B* may be connected with no change in voltage on the transformer. In this position the line terminal *X* is connected directly to the terminal *B*, so that *Y* and *A* may be disconnected without spark and without change in voltage. If now the primary of the regulator be reversed, the secondary voltage will be that shown in position 3 *A*, and will be equal to that from *B* to *C*, so that *Y* may be connected to *C*, and then *X* disconnected from *B* without changing the voltages of the system. The regulator now bears the same relation to the point *C* that, at the start, it did to the point *A*, so that if the rotation be continued the secondary e. m. f. will be gradualy increased as before. and a the proper point *X* may be connected to *D*, *Y* disconnected from *C*, the primary of the regulator reversed, *Y* connected to *E*, *X* disconnected from *D*, etc. It will be noted that although in passing from *A* toward *E* the voltage between loops is increasing, the primary voltage of the regulator is also increasing, so that the maximum secondary voltage of the regulator is always just equal to that between adjacent loops. The maximum voltage on secondary of transformer will be obtained when *Y* is connected to *J*, and the maximum voltage of the regulator is added to that of the line. It is evident that to reduce the secondary voltage of the transformer it is only necesary to reverse the direction of rotation of the regulator, so that it moves along the loops from right to left, the minimum voltage being obtained when *Y* is connected to *A*, and the maximum voltage of the regulator opposes that of the line

The numerous loops from the primary of the transformer and the primary and secondary terminals of the induction regulator are carried to a dial, on which are made the proper changes in connections from point to point. As will be seen in the engravings, the dial is placed on top of the induction regulator, to which it is rigidly fastened. The hand wheel at the side of the regulator is connected through a worm gear to the secondary of the induction regulator, and through bevel gears to the contact fingers on the dial. When the hand wheel is turned the secondary of the regulator is rotated until a maximum secondary voltage is obtained; at this point a spring inside the dial, which has been put in tension by the rotation of the secondary, is released and carries through the series of changes necessary in stepping from one contact to another; i. e., *X* is connected, *Y* disconnected, primary reversed, *Y* advanced to the proper contact and *X* disconnected. Although this series of changes is made almost instantaneously the proper order is always rigidly maintained.

The housing of the dial is provided with numerous doors, which afford ready access to any part of the mechanism.

The case of the induction regulator is filled with oil, which is kept cool by the circulation of water through a few turns of copper tubing placed just below the surface of the oil.

When the transformer is delivering its full load of 750 kilowatts the current in the secondary of the regulator is approximately 340 amperes, and as the maximum secondary voltage is 100 the maximum capacity of the regulator is only 34 kilowatts. The energy loss in a regulator of this size is of course very much less than it could be made in a regulator the size of that in the original plant, and as its magnetizing current is very much lower the power factor of the plant is higher.

The capacity of the transformer for the new plant is 750 kilowatts, and it is of the Westinghouse standard, oil-insulated, water-cooled type. The coils are of heavy copper strap, primary and secondary being interlaced, to reduce magnetic leakage, and spread apart outside the iron to allow a free circulation of the oil between the coils. The primary coils are cross-connected in such a manner that there is but little change in the magnetic leakage, as the number of turns are varied, so that the self-induction of the windings is but slightly affected. The case is of boiler-plate, with cast-iron base and cover. The general construction of transformer and case may be clearly seen in the illustrations.

The transformer and regulator in both old and new plants are of the water-cooled type, but the method of utilizing the water for cooling is quite different in the two cases, although in both cases water is passed through pipes immersed in the oil. In the original plant there is a large cooling tank mounted several feet above the top of the transformer which contains the water-cooling coils. The hot oil from the transformer and regulator is pumped into this tank, where it is cooled, and is then allowed to flow by gravity back through regulator and transformer. The oil is forced into the cooling tank by means of a pump, which is driven by an alternating-current motor. A second tank, placed below the one for cooling, serves to catch any oil which may chance to overflow in case the outlet pipe should become stopped.

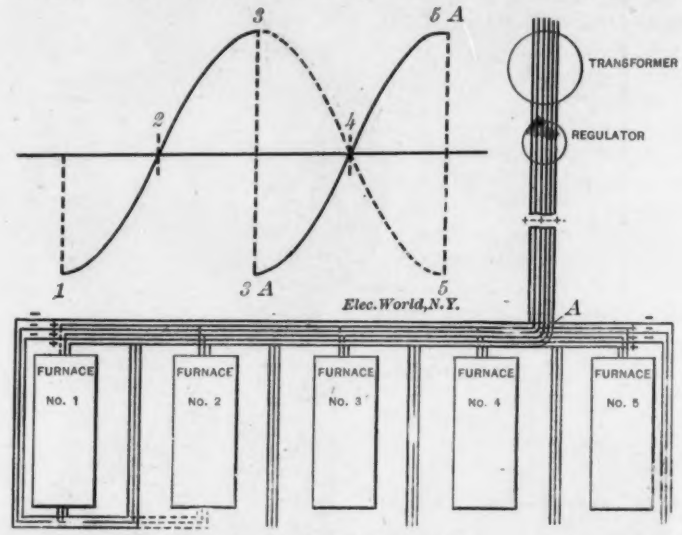
In the new plant the cooling is done by means of a few turns of pipe placed inside the cases of transformer and regulator. These coils are connected directly to the water mains, and any desired amount of water may be passed through them. In this manner the oil is cooled without being removed from the transformer case.

The necessary instruments for operating the new transformer plant are mounted on a special marble switchboard. The measuring instruments are of the Schallenberger "Niagara" type, and consist of a voltmeter, an indicating wattmeter and a recording wattmeter. The voltmeter is connected across the secondary terminals of the transformer, and the wattmeters are operated from series and shunt transformers in the primary circuit. The transformer is protected by a single-pole circuit breaker shown at the top of the board, and may be disconnected entirely from the circuit by means of a double-pole switch. A water resistance, in series with the primary circuit, is used ordinarily in starting up or shutting down, in order that the full load may not be too suddenly thrown on or off. The circuit breaker is, however, capable of opening the 2200-volt circuit, with full load on the transformer, whenever it is desired to do so.

It was stated above that the self-induction in the transformer was reduced as low as possible by subdividing the coils. In the secondary circuit, which is long and carries enormous currents, it was also necessary to adopt means for preventing the excessive self-induction or counter e. m. f., which would occur if the current were carried by single conductors. The effect of this self-induction is to reduce the power factor and to impair the regulation of the system. The secondary of the transformer is divided into six equal coils, connected all in multiple. The start and finish of each coil are brought out and connected to the conductors leading to the furnace room, there being a separate conductor for each end of each coil. The arrangement of the conductors is such that those of one polarity alternate with those of the opposite polarity, so that there are six separate circuits for conveying the current. By this subdivision the counter e. m. f. in the circuit and the eddy-current loss in the conductors themselves are very greatly reduced.

In the furnace room there are two rows of furnaces, with five furnaces in each row. One row is supplied from the old transformer plant, the other from the new. The general arrangement of conductors in the plant is shown in Diagram IV. The interlacing of conductors is carried out as far as possible, and where it is necessary to carry the current to the rear of the furnace two circuits, one on each side of the furnace, are used, thus keeping down the self-induction in this part of the circuit to as low a value as possible.

For conveying the current from the transformers to the furnaces more than 7½ tons of copper are used. In calculating the most economical drop it was necessary to take into account both the cost of power and the length of time that any section of the conductor would be in service. As only one furnace is in operation at a time, it is evident from Diagram IV. that conductors which supply only No. 1 or No. 5 are in service one-fifth the time; those which



Diagrams III. and IV.

supply both No. 1 and No. 2 are in use two-fifths the time, etc., while those leading from the transformer to point *A* are in use all the time. The greatest cross-section of conductor is therefore from transformer to point *A*, while the least section is that which supplies only a single furnace.

In comparing the new installation with the old we find:

First. A simpler method of cooling the transformer and regulator; a method which requires neither tanks, motor nor pump.

Second. A regulator requiring only a small fraction of the capacity necessary in the original one, therefore having but a small fraction of the loss, and affecting but slightly the power factor of the plant.

Third. A system of secondary conductors, which, being thoroughly interlaced, introduce but little self-induction into the secondary circuit, and, consequently, reduce but slightly the power factor of the load; and which, being carefully proportioned for the service for which they are intended, transmit the proper amount of current with the greatest possible efficiency.

Electrically Driven Stage Lifts.

In the Drury Lane Theatre, London, the stage floor is being equipped with sections movable vertically by electric motors. Some 1200 square feet of the stage floor is thus transferable for a distance of 20 feet vertically, each individual section weighing about 6 tons. These sections are designed for the production of terraces, pits, etc.

Electricity and Population in the Cities of the World.

R. S. HALE AND J. S. CODMAN.

When the Boston Edison Company was preparing its exhibit for the recent Mechanics Fair in Boston it desired to show the comparative use of electricity in the different cities of the world and requested the writers of this paper to prepare such statistics. At first sight it appeared as though data and material were ample, since the American Electrical Directory, Johnston's Electrical and Street Railway Directory, the official reports of some of the companies, the official State reports, figures published weekly in English "Lightning," and annually in the London "Electrician," and the "Electroteknische Zeitschrift," and the frequent reports in the electrical papers seemed to cover the ground. If the figures obtained from the source first consulted had been used the work would have been very simple, but it was soon discovered that the authorities differed to a very great extent, either by reason of inaccurate reports or by reason of varying standards, or dates of report. The latter is probably the most frequent cause of variations, since when an electric company is increasing its business at the rate of 20 or 30 per cent., yearly reports made at the first of the year and reports brought up accurately to date are apt to vary largely.

In addition to the figures for total lamp installation in the different cities it was desired to present a comparison between the lamp installation and the population of the different cities, and while it was to be expected that the figures for lamp installation would vary in the different reports it was a surprise to the writers to find that figures for population of the great cities also varied by a very large amount. Thus, for instance, the different authorities gave the population of Baltimore at figures varying from 434,000 to 600,000. Rome varied from 273,000 to 484,000, and there were similar variations in other cities.

Perhaps it would have been possible by corresponding with the different companies of the world to obtain, if not absolutely accurate figures, at least figures more accurate than those given below; but as the figures were desired for immediate use, and since in any case the figures would be obsolete and misleading in the course of a year or so, it was thought that the rough comparison, as finally made up, would be sufficiently accurate for the purpose.

The various figures are given below, the largest figure being taken when authorities differed. They show the population of a number of cities, and also show the total equivalent installation of the electric companies (but not including the street railway companies), expressed in incandescent lamp equivalents, taking each arc lamp at 10 incandescents and each horse-power of motors at 15 incandescents. The figures for isolated plant installation are also given for a number of cities, and the method of obtaining these should be explained. The only data obtainable were the figures in Johnston's Electrical Directory, and these do not always give the lamp installation. The first 100 plants in these lists for each of the large cities which gave the lamp installation were averaged, this giving a figure of lamps per isolated plant for that city, and this figure upon being multiplied by the total number of isolated plants gave a figure for total lamp connection in isolated plants. For the smaller cities the figure for lamps per isolated plant was estimated. These methods very likely give inaccurate results, but probably no more inaccurate than any other method that was available.

The figures for lamps per 1000 inhabitants are, of course, obtained by dividing the lamp installation by the population, and multiplying by 1000.

The authors of the report realized as fully as any one the possibility or even the probability of the inaccuracy of these figures, since errors may be due to many causes. Some of the companies have probably included break-down connections of isolated plants in their figures, while others have omitted them; probably some of the figures include power use for street railway work; some of the companies situated in a large city feed only a portion thereof; others may even extend beyond the borders of the population on which the figures of lamps per 1000 inhabitants are based. The figures for isolated plants are, of course, even more subject to error, and it is probable that none of the figures can be relied upon to within 25 per cent., if they are as close as that.

Nevertheless, the general average of the figures is probably not very far from the truth, and may serve as a point of comparison some years hence. The difference shown between American cities and foreign cities is also beyond the limit of error of the figures, and the managers of American stations should be congratulated on the results.

		Lamps, arcs and motors in 16 cp. equivalent.			Lamps per 1,000 Inhabitants.	
City.	Population.	Central stations.	Isolated plants.	Total.	Central stations.	Total.
Boston	500,000	418,000	198,000	616,000	836	1,232
New York	2,000,000	978,000	740,000	1,718,000	489	859
Chicago	1,750,000	513,000	765,000	1,278,000	294	730
Brooklyn	1,125,000	267,000	55,000	322,000	237	286
Baltimore	600,000	188,000	36,000	224,000	313	373
Philadelphia	1,390,000	366,000	122,000	488,000	282	375
St. Louis	656,000	271,000	122,000	393,000	413	600
San Francisco	350,000	209,000	22,000	231,000	598	660
Buffalo	375,000	85,500	40,000	125,500	228	335
Rochester	178,000	175,000	9,000	184,000	982	1,040
Cincinnati	365,000	173,000	28,000	201,000	475	551
New Orleans	280,000	70,000	11,000	81,000	250	289
Vienna	1,574,080	388,000	.....	.....	246	....
Paris	2,511,000	365,000	.....	.....	185	....
Brussels	531,000	48,000	.....	.....	90	....
St. Petersburg	1,035,000	60,000	142,000	202,000	58	195
Rome	473,000	60,000	.....	.....	127	....
Berlin	1,667,000	298,400	.....	.....	178	....
Hamburg	625,500	83,900	.....	.....	134	....
Breslau	373,000	28,300	.....	.....	76	....
Leipsic	400,000	41,900	.....	.....	105	....
Bremen	142,000	48,000	.....	.....	338	....
London	5,000,000	920,000	.....	.....	184	....
Birmingham	478,000	36,600	.....	.....	75	....
Leeds	390,000	25,000	.....	.....	64	....
Liverpool	636,000	67,600	.....	.....	106	....
Manchester	530,000	91,700	.....	.....	173	....
Sheffield	338,000	28,000	.....	.....	83	....
Dublin	252,000	11,000	.....	.....	44	....
Edinburgh	261,000	63,000	.....	.....	242	....
Glasgow	817,000	59,000	.....	.....	72	....
Brighton	121,000	43,000	.....	.....	353	....

A Lag Indicator.

To the Editor of The Electrical World:

In an editorial on synchronizing alternators, which appeared in your issue of October 8, a piece of apparatus is mentioned which may be altered so that it will indicate directly in degrees the lag or lead of current in any polyphase circuit.

The indicator would consist of two concentric rings of laminated iron. The outer and stationary one, assuming it to be used on a three-phase circuit, would have three coils of heavy wire wound so as to produce a rotating field, and so proportioned that they could be put in series with the leads of the circuit whose phase relation was to be measured. The inner ring should be mounted so that it could rotate through at least 180 degrees, and be wound with three fine-wire or potential coils connected so as to produce a rotating field. These coils would be connected across the three-phase circuit by flexible wires. Let both fields be joined up so that they will rotate in the same direction.

Assume that the indicator is first put on a non-inductive circuit. It is obvious that the inner ring will be attracted and swing into such a position that its poles will come opposite the poles due to the outer ring. A pointer fastened to the inner ring and passing over a graduated scale should now be adjusted so as to indicate *o*. Now, if the current is made to lag, say, 20 degrees, the poles in the outer ring due to this current will lag 20 degrees behind the poles due to the fine wire winding; hence the inner ring will swing back 20 degrees, so that its poles will again be opposite the poles of the outer ring. Thus the pointer would indicate 20 degrees lag. If the current lead the volts, the inner ring would swing forward a corresponding amount. It is evident that a change of frequency would not alter the indications of this instrument. By designing the apparatus large enough for it to have sufficient torque to turn a rheostat handle—which would be connected in the alternator field—it would seem as if it might be used to partly overcome the sudden fall in potential due to throwing in an induction motor or any other piece of inductive apparatus. The first rush of lagging current would cause the rotating part of the regulator to swing through an arc proportional to the disturbance introduced into the circuit. This movement being transmitted to the rheostat handle would cut out resistance and so strengthen the alternator field, thus tending to keep up the voltage of the circuit.

As the induction motor came up to speed, the current comes more in step with the voltage, and so the regulator would be drawn back, turning resistance into the alternator field and lowering the voltage.

P. G. WATENOUGH, JR.

SCHENECTADY, N. Y.

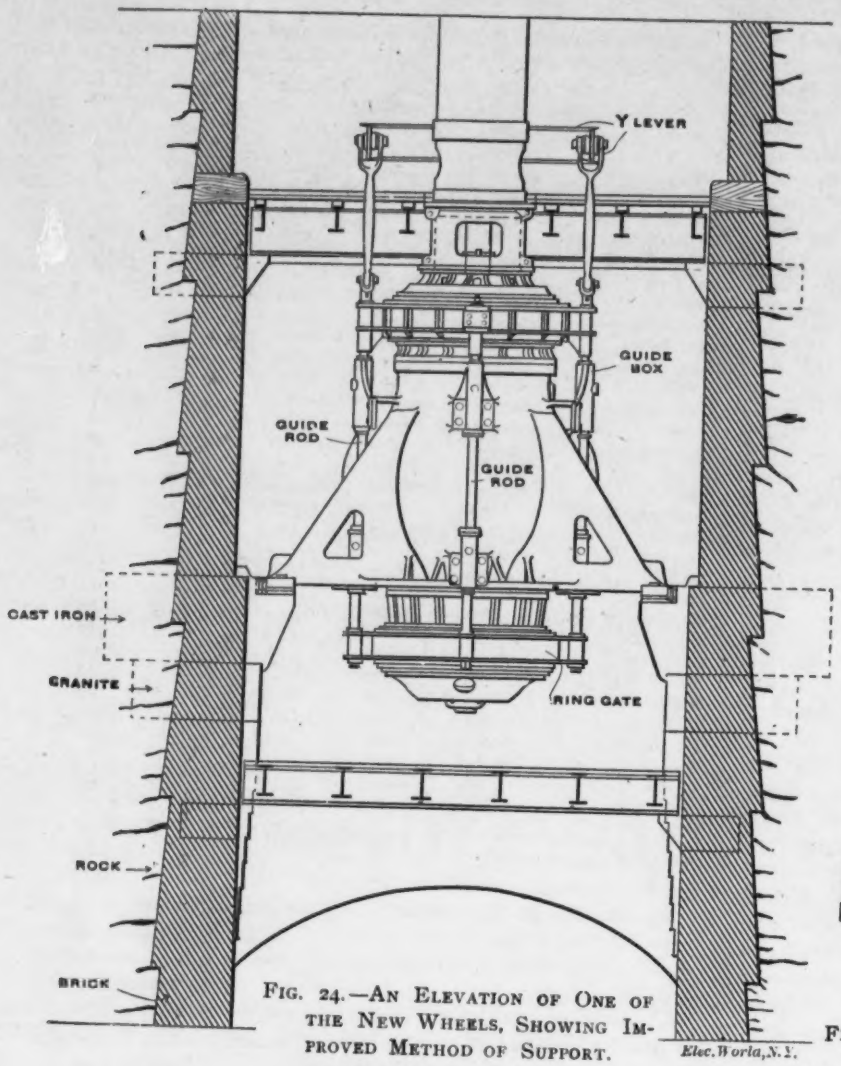
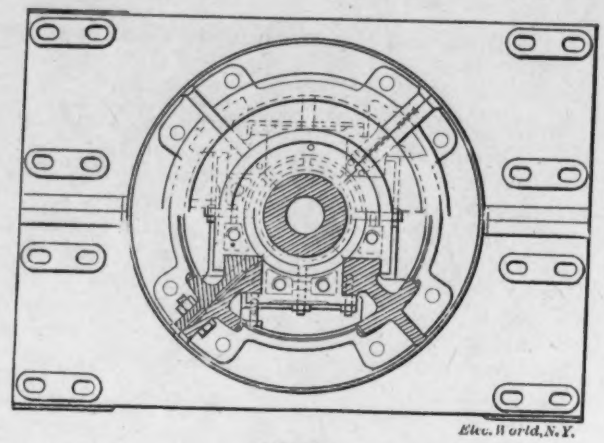


Fig. 24.—An Elevation of One of the New Wheels, Showing Improved Method of Support.

Elec. World, N.Y.



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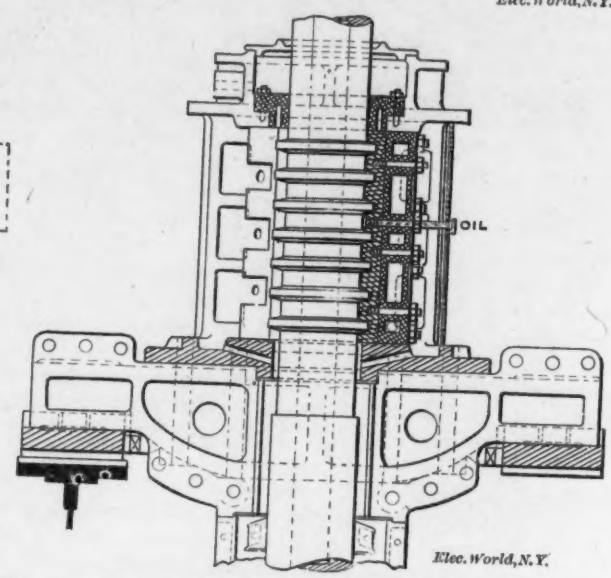

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Fig. 27.—Sectional Plan and Elevation of Improved Thrust Bearing.

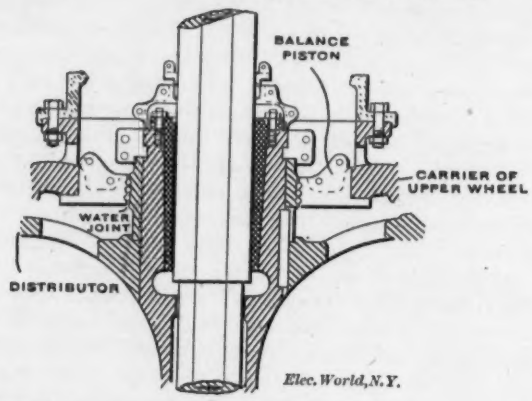

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Fig. 25.—A Section of the Upper Turbine Bearing, Showing Balance Piston.

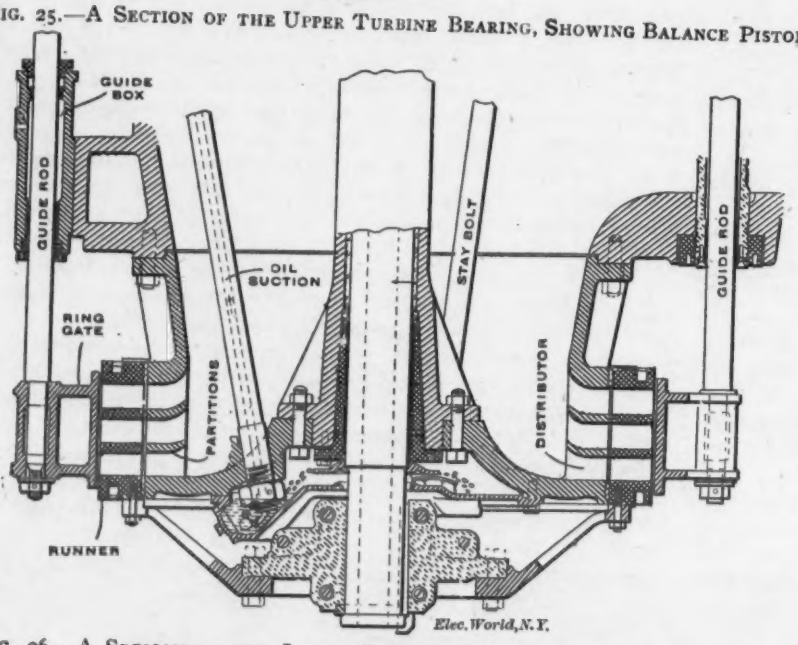

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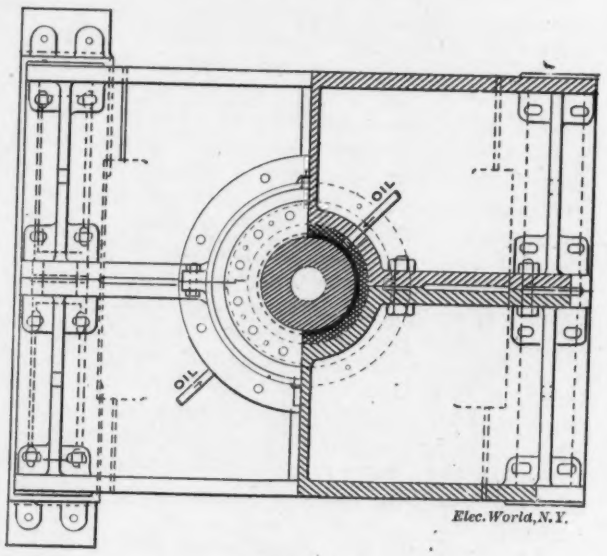
Fig. 26.—A Section of the Lower Turbine, Showing Arrangement of Distributor, Runner and Gate.



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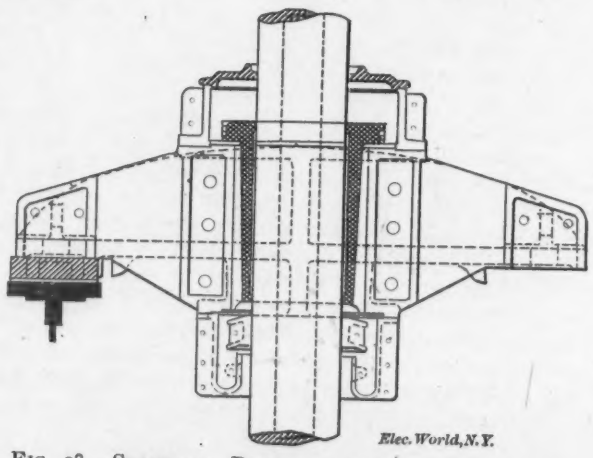


Elec. World, N.Y.

Fig. 28.—Sectional Plan and Elevation of Improved Intermediate Bearing.

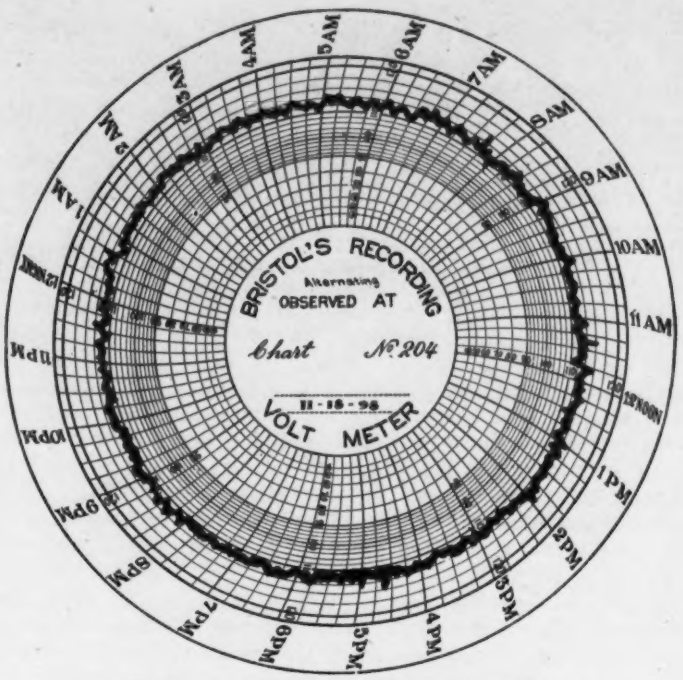


FIG. 29.—A TYPICAL DAY'S VOLTAGE CURVE.

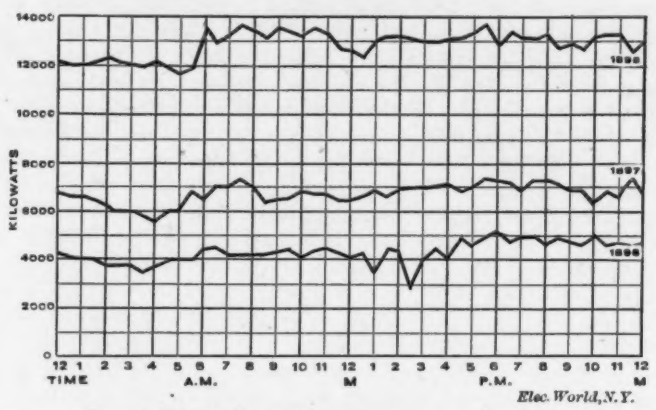


FIG. 30.—THREE DAILY LOAD CURVES FOR THE SAME DAY IN 1896, 1897 AND 1898, RESPECTIVELY.

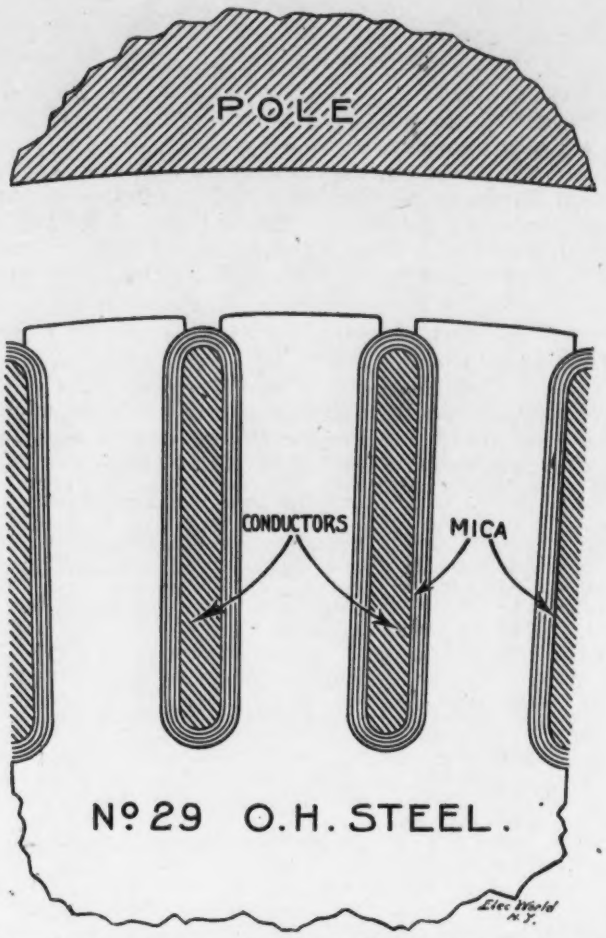


FIG. 31.—ARRANGEMENT OF ARMATURE TEETH AND SLOTS OF THE NEW MACHINES, ACTUAL SIZE.

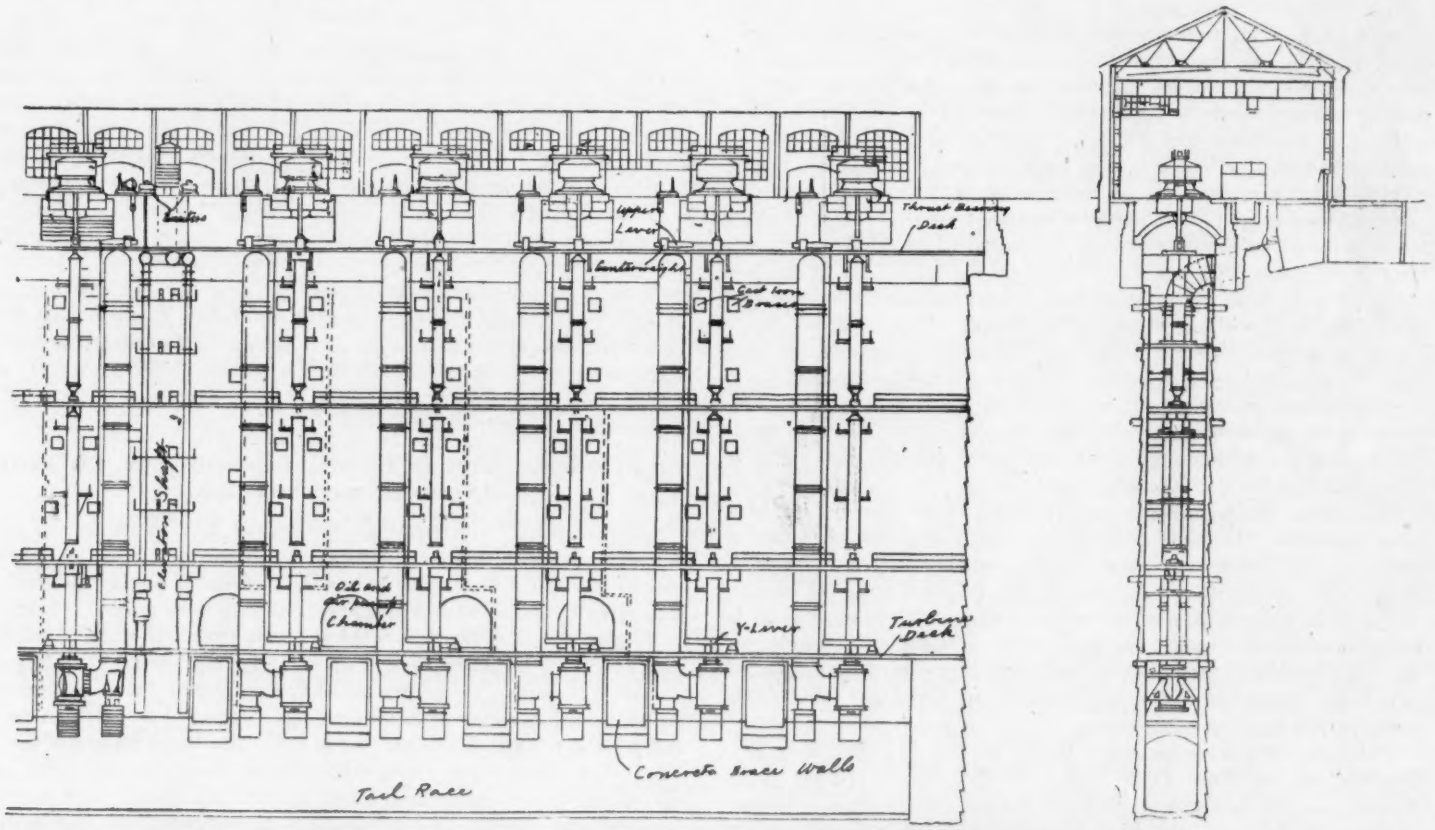


FIG. 32.—SECTIONAL ELEVATIONS OF THE WHEELPIT ADDITION, SHOWING MACHINES 4 TO 10 IN PLACE.

New Specifications for Wire Coverings, Fittings, Etc.

At the annual meeting of the Electrical Committee of the Underwriters' National Electrical Association, which was held in New York City on December 6, 7 and 8, a special committee was appointed to draw up specifications for wire coverings, to compile a list of fittings acceptable for use under the rules and to take up other matters in connection with the National Electrical Code. This committee will hold a meeting at the offices and laboratory of the Electrical Bureau of the National Board at 157 La Salle Street, Chicago, beginning January 9. Manufacturers of insulated wire have been invited to be present at certain hours during the meeting when the experimental records of their products will be brought up for consideration and discussion. The following proposed specifications for rubber-covered wires, prepared by the Electrical Bureau, will come up for action:

40. WIRE INSULATION.

(*a*) Rubber. Insulating compounds containing rubber must conform to or be in excess of the measurements given in the following table which shows standard thickness of insulating walls for standard wires and cables:

TABLE.

B & S.	Mils. Thickness of wall.	Mils. Diameter over rubber.
18	.0411	.122
16	.0437	.138
14	.0469	.158
12	.0512	.183
10	.0565	.215
8	.0631	.255
6	.0715	.305
5	.0764	.335
4	.0821	.368
3	.0883	.406
2	.0954	.448
1	.1033	.496
0	.1122	.549
00	.1222	.609
000	.1334	.676
0000	.1460	.752

The above table is based upon the following formulæ which may be applied for conductors larger than No. 0000.

Rubber diameter = 3/2 copper diameter + 62.

Thickness of rubber wall = ¼ copper diameter + 31.

As the dielectric strength of a rubber wall is determined by its thinnest portion, all measurements shall be taken across the smallest diameter of the specimen tested. When depressions are caused by the braid or in process of manufacture, the lower surfaces of the channels caused by these depressions must be taken as the exterior surfaces of the wall. For a correct reading the measuring instrument must just shut out a line of light between the material being measured and the terminals of the instrument.

All of these insulations must be protected by a substantial braided outer covering sufficiently strong to withstand all abrasion it will meet with in practice and sufficiently elastic for all wires smaller than No. 5 B. & S. gauge to admit of the conductor being wound back over itself without injury to the braid.

The completed covering must show an insulation resistance of at least 100 megohms per mile throughout eight weeks' immersion in hydrant water at ordinary temperatures. Each foot of the completed covering must show a dielectric strength sufficient to resist throughout five minutes the application of an alternating e. m. f. of 16,000 volts under the following conditions:

The source of alternating e. m. f. shall be a transformer of at least 1-kw capacity. The application of the e. m. f. shall first be made at 4000 volts for five minutes and then the voltage increased by steps of not over 3000 volts, each held for five minutes until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample of wire, one foot of which is submerged in a conducting liquid held in a metal trough, one of the transformer terminals being connected to the copper of the wire and the other to the metal of the trough.

The committee is composed of W. H. Merrill, Jr., chairman; J. C. Forsyth, of the New York Board of Fire Underwriters; E. V. French, of the Associated Factory Mutual Insurance Companies; William McDevitt, of the Philadelphia Fire Underwriters' Association; A. M. Schoen, of the Southeastern Tariff Association; J. E. Cole, of the Boston Wire Department, and Edward B. Ellicott, city electrician of Chicago. Acting with the committee will be E. A. FitzGerald, of the Underwriters' Association of New York State; A. E. Braddell, of the Underwriters' Association of the Middle Department; J. M. DeCamp, of the Suburban Underwriters' Association; Franklin H. Wentworth, Theodore Varney, W. S. Boyd and Benjamin H. Glover, of the Electrical Bureau, and a number of other officials.

"The Electrical World's" Moonlight Tables.

For several years The Electrical World has published in December a Moonlight Schedule for the year following, compiled by Mr. H. W. Frund, of Vincennes, Ind., together with the tables on the "Standard" system. An inquiry was recently received for an explanation of the differences between the two schedules. These differences, as pointed out by Mr. Frund in his reply, are given herewith for the benefit of those readers of The Electrical World who are interested in the subject.

Mr. Frund writes: "The features noticeable in my system, which has been in use in so many places as far back as 1890, are, first, that the lights always burn every night until midnight; second, that after midnight the moon schedule is followed, and, third, that during the three nights immediately preceding full moon the lights are not turned on after midnight. I proposed the latter modification of the usual lighting table to our city government years ago, and the suggestion was accepted for the good reason that in these three nights the old tables give but an hour or less lighting, and even that is well on toward sunrise. It is obviously a great expense to light the lamps for a few minutes, and the light is in reality hardly needed, for the difference between moonset and sunrise is then such that an abundant twilight is afforded. Thus it will be seen that by taking the calendar for any such day just previous to full moon the need for lights after midnight is practically nil, especially when it is remembered that the ordinary moonlight tables require the lamps to be lighted one hour before moonset. It sometimes might even happen that the lights would be burning with the moon still above the horizon and the sun already there. This waste is what I avoid." He notes that by the adoption of his schedule considerable gain is made over all-night lighting economy and over moonlight lighting in usefulness. His plan gives 3000 hours lighting per annum; all-night lighting gives 4000 hours and the moonlight table 2200. He states that this plan is considered quite as good as the all-night schedule.

The Proposal of a Municipal Hydraulic Lighting Plant for Chicago.

City Electrician Ellicott, of Chicago, has proposed publicly that the city should utilize the available water power of the new drainage canal for an electrical generating plant to light the city streets. He gives the following figures: There are now in use 2981 arc lights, of which 2450 are supplied by the three municipal plants. Coal for these costs $2.02 per ton, making the fuel item a large proportion of the total expense per lamp, which is $69 per year. To light the city properly by arc lights would require 13,000 of the latter, requiring perhaps at Joliet, where the hydraulic power is available, almost the same number of horse-power. Roughly figuring this as the cost of hydraulic power is usually estimated, it would cost $15 per hp-year as against $45 per hp-year, as under the present method of generation. It is estimated that with the anticipated flow of 600,000 cubic feet of water per minute, the fall between Lockport and Joliet would give 60,000 horse-power.

An Experiment with an Electric Locomotive on the Paris-Lyons-Mediterranean Line.

An experimental electrical locomotive has been in service on this French railway in order to get data as to the performance of this sort of traction. According to the data given in foreign papers, it is apparently a single-truck machine with two motors direct-coupled fo the two axles. These are rated at about 300 horse-power each, at 500 r. p. m. The locomotive drags a tender containing a battery of 192 storage cells. It weighs about 90,000 pounds, and has drawn trains weighing about 300,000 pounds at a speed of 30 miles an hour and 200,000 pounds at double that speed. The latter weight is given by French journals as about half that of their express trains, so that a double equipment could pull them at full speed. The battery is, of course, merely an experimental arrangement, the use of the third rail being proposed for any permanent installation.

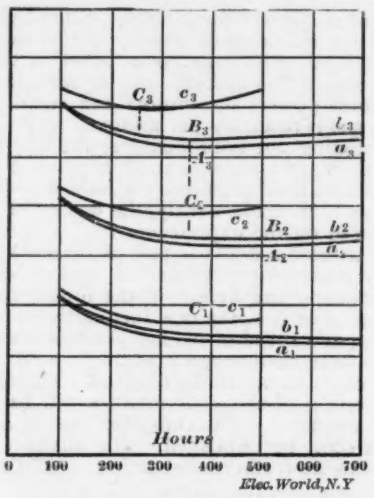
DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering

(NOTE.—Owing to the increasing amount of matter published on electrical subjects, the following changes have been made in the "Digest." Greater space will be devoted to the abstracts of the more important articles, which will be illustrated whenever necessary for clearness. The other articles of the week will be noticed, as heretofore, by references, which will be grouped together in more condensed form, and will not include the large number of articles which appear to be of little or questionable value, or are of an elementary nature, or in general do not appear to be of sufficient interest. The abstracts and references will be limited more strictly to the subject of electrical engineering, as distinguished from physics, chemistry, mechanical engineering, civil engineering, etc. Long serials, when merely referred to, as distinguished from being abstracted, will in general be noticed only once. Digests of patents as a rule will not be noticed. References will, as usual, be given to translations of important articles, or to reprints of articles in the more accessible journals. As heretofore, the author's original phraseology will be used in the abstracts or descriptions of articles as much as possible, especially where the meaning is doubtful or not sufficiently clear; the compiler's criticisms are generally in parentheses. Papers read before American societies, and other articles, reprints or translations which have been published or duly noticed in the other columns of THE ELECTRICAL WORLD, will not again be mentioned in the "Digest.")

Lights and Lighting.

ECONOMICAL LIFE OF INCANDESCENT LAMPS.

A short article in which the author applies the well-known Keenan method of determining what is sometimes called the "smashing" point of incandescent lamps, to Randall's data for a number of lamps. This smashing point is the time in the life of a lamp at which it becomes more economical to replace it with a new one, on account of the reduced efficiency of the lamp. After describing the method briefly and giving some of the data obtained by Randall, he deduces the curves, which are reproduced in the adjoining illustration. The first set of lamps had filaments of cellulose, the second treated, and the third untreated bamboo filaments. The curves are determined for each of three prices for the current, namely, 14.4, 9.6 and 4.8 cents per kw hour; the cost of the lamp is assumed to be 16 cents. The curves marked *a* are for the first-mentioned lamps, those marked *b* for the second, and those marked *c* for the third, the three curves in each case being for the three different prices of the energy. The proper life can be seen by the minimum point of each of the curves; for the two lower it is beyond the 700-hour limit of the tests. From this it appears that a good 16-cp lamp of 110 volts, consuming about 50 watts, whose candle-power, after 700 hours, is diminished only 10 to 15 per cent., and the consumption of energy increases 10 per cent., can in general be left in circuit for about 350 hours; only where the price of the energy is low can they be run to advantage up to 500 hours; when the lamps are not as good as this the life should be still further diminished.—Montel. "Zeit. fuer Elek.," Dec. 11.



SUSPENSION FOR ARC LAMP.

A brief, illustrated description of the device illustrated in the next column and made by a German manufacturer. The object of the arrangement is to avoid the use of the unsightly slack in the conductors of an overhead lamp which is to be lowered for trimming; also, the complete disconnection of the lamp from the circuit when it is being trimmed. The arrangement is shown quite clearly in the illustration, the lamp being suspended from the loop at the bottom of the cord, and has its leads connected to the lower portion of the apparatus. The contacts are made by the two concentric rings, only the lower set of which are provided with spring contacts, as shown. An important feature is the spiral spring connection near the top, which avoids the shock in case the lamp is raised too quickly. The bell form of the cover of the switch protects the latter from rain.—"Elek. Zeit.," Dec. 15.

REFERENCES.

Cost of Gas and Electricity.—Some curves and formulas enabling the relative cost of the meter bill for gas and electric lighting to be determined readily for different prices of gas and electric current.—Lond. "Elec. Eng.," Dec. 16.

Power.

WATER-POWER PLANT AT PADERNO.

The beginning of an illustrated description of this plant, in which 13,000 horse-power is transmitted 20 miles; it is claimed that there does not exist another installation so complex and so varied in its applications; the present portion refers entirely to a brief description of the hydraulic portion of the installation, of which the technical journals have published full particulars. Each point of the installation "was thought out and chosen with that spirit of caution and striving after perfection which we of the Old World—as opposed to American engineers—are accustomed to carry into new and daring enterprises." The late Ferraris devoted much care and thought to this plant. The volume of water has a cross-section of 180 square feet, and for the delivery of 10,000 gallons the velocity is 8.9 feet per second; this is the delivery in times of draught; the net fall in dry seasons is 94.5 feet, which is reduced to 81.6 in times of flood, and the delivery is then increased in proportion; the power represented by this fall of water is 17,300 horse-power, which gives an output of nearly 13,000 horse-power. There are six units of 2160 horse-power each, with a seventh as reserve; 75 feet of the fall acts by pressure and 19.5 by suction, so that it is possible to keep the floor of the dynamo room above the level of the highest flood. The turbines are the most powerful made, with the exception of those in Niagara; they are of the inward-flow type, with twin wheels. The variation of speed allowed is 2 per cent. during normal running and 4 per cent. for 25 per cent. variations in the load. The Siemens system for varying the speed of the governors will be used in order to facilitate running in parallel; "this simply consists of a small motor worked from the switchboard, which stretches or releases the spring opposed to the conical pendulum governor. By this means the switchboard attendant can adjust the speed of each turbine—or their load if running in parallel—by simply pressing a button. The turbine is connected to the alternator by means of an elastic coupling."—Semenza. Lond. "Elec.," Dec. 16.

DISTRIBUTION OF ALTERNATING CURRENTS.

The beginning of a serial in which the author intends to indicate the apparatus and methods in most general use, with comments on them. In discussing the general conditions of economy he quotes two examples, in which the conditions are very different; in the former an arrangement of plants which cannot be recommended in the abstract has enabled profit to be made under circumstances which would have debarred a more efficient and expensive system from doing so, while in the second the adoption of a more efficient and a permanent plant has resulted in a loss, while a more modest beginning, with a more elastic system, would have insured a profit from the outset. High-tension feeders are then discussed, and he shows that a compromise is the best solution when absolute security is to be balanced against cost, in determining the location of the station and the duplication and interconnection of feeders. The use of discriminating cut-outs is recommended. The capacity current of the Deptford trunk lines, which have a length, when looped, of nearly 12 miles, is between 12 and 14 amperes at 10,000 volts, and this wattless current must be allowed for in the size of the copper mains and machinery. Twin cables have an induction which is lower than that of a double conductor, and their capacity is higher; they are used largely where a quantity of double cable has already been installed, and it is inadvisable to use a combination of double and concentric mains. For ease of handling and cheapness of joining the ordinary double-insulated cable decidedly takes first place, the joining of concentric cables being costly; they can be drawn into ducts at greater lengths than lead-covered cables, but they are expensive. Paper insulation is extremely weak mechanically, and is hygroscopic, but the manufacture of such cables is so satisfactory now that immense quantities are being laid and used successfully. There has been a decided prefefence lately for armored cables laid directly into the ground. It costs less than a lead-covered cable in a conduit, but this does not always justify its use. He recommends a transformer with variable change ratio, or some equivalent device

in each feeder circuit, for counteracting the drop in volts at full load. —S. E. T. Ewing. Lond. "Elec. Eng.," Dec. 16.

REFERENCES.

Transmission and Distribution by Alternating Currents.—A reprint in full of a very long paper in which the author discusses the various problems relating to the production and utilization of alternating currents, with the object of finding means by which they may be made to have the advantages of continuous currents, while at the same time maintaining their own characteristic properties. He describes the following systems: One for compounding alternators for a constant voltage, while at the same time enabling their armature reaction to be increased as much as one likes; a system for facilitating the parallel connection of alternators and assuring the stability of their synchronism; a system of generators capable of furnishing currents in phase or not, with their e. m. fs., of operating at a constant voltage or current, and of being connected in parallel or series; a system of excitation of non-synchronous motors, enabling them to have the same air space as synchronous motors, making the cosine of the angle of lag as nearly unity as one wishes, or even negative; a system of transforming alternating into continuous currents. The paper is theoretical in character, but is accompanied by experimental verifications.—Leblanc. "Bul. Soc. Int.," Nov.

"L'Ind. Elec." and "L'Eclairage Elec.," Dec. 10, reprint an Academy paper by him on induction machines used as generators or receivers of simple or polyphase currents. He describes experiments made to verify a phenomenon, an account of which he published some years ago.

"L'Ind. Elec.," Nov. 25, and "L'Elec.," Dec. 10, reprint his Academy paper, describing his method of compounding constant potential alternators, mentioned above and described also in the complete paper.

Elevator Controller.—A brief, illustrated description of one made by the English General Electric Company, for which great advantages are claimed.—Lond. "Elec. Rev.," Dec. 16.

"L'Eclairage Elec.," Dec. 10, begins an article by him on this subject, which is quite similar to the above.

THE SNOQUALMIE PLANT.

An editorial statement of the present condition of the work on this interesting plant. During January two noteworthy transmission plants on the Pacific slope will probably be inaugurated. The first will be that of the Southern California Power Company, with its 80-mile, 33,000-volt line into Los Angeles, and this will be followed by the Snoqualmie plant, which transmits power to Seattle and Tacoma, and is of special interest owing to its high voltage, its capacity and its use of aluminum wire. The line will be completed to Seattle, a distance of 31 miles, about the middle of December. Although descriptions of this plant have been published, a brief summary at this time may be of interest. The poles carry six wires, each 263 miles in diameter, arranged in two three-phase circuits, one on each side of the pole, each circuit being in the form of a triangle, having 36-inch sides, and one of the circuits will be spiralled at six points. The aluminum wire is shipped in lengths of about 1500 feet, and the joints are made of a tubular sleeve slipped over the two ends and firmly twisted. The elastic limit of the wire is 800 pounds, and tests have shown that the sleeve-joint is stronger than the wire. The wire has a conductivity of 60 per cent. of that of copper of equal section, and its weight is about one-half of that of No. 4 copper wire; aluminum is also used for the tie wires and the telephone circuits. The two circuits to Seattle will deliver 4000 kw at 25,000 volts, with a loss of 15 per cent. Work has not yet been begun on the line to Tacoma, which leaves the other line at an intermediate point. The generating equipment will consist of four 1500-kw, 1000-volt, revolving-armature, three-phasers. The high frequency of 7200 was used so that arc lights may be put on the circuits. It is expected that the line to Seattle will be put into service on Jan. 15.—"Jour. of "El'ty," Nov.

SAN GABRIEL-LOS ANGELES TRANSMISSION.

A very long and well-illustrated description of this plant which, in an engineering sense, is said to be "the very quintessence of novelty, originality and boldness of design in many of its most important features." It resembles the Hartford installation more than any; both of these are driven by water power; each has an auxiliary steam plant, and each delivers direct current, lighting and power service from rotary converters; the difference is that the Hartford plant has a storage battery, while the present one gives or takes a 500-volt direct current from the power circuits of the Los Angeles Railroad Company, thus equalizing the load factor and providing for a reserve. By far the greater portion of the article is devoted to a description of the hydraulic engineering features. At the end of the article there is a good summary of the engineering data. At the Azuca power house there are four generators of 300 kw each, two-phase, 400 to 500 volts, running at 430 revolutions, the frequency being 50. There are four oil-insulated, air-cooled transformers of 250 kw each, transforming the two-phase current to 15,000 or 17,000 volts and to three-phase currents, by the Scott system. The length of the line is 23 miles, there are two three-phase, three-wire circuits of No. 5 hard-drawn copper, the distance between wires being 24 inches. The total transformer capacity at the Los Angeles sub-station is 1750.—Low. "Jour. of El'ty," Nov.

REFERENCES.

Electric Rock Drill.—A brief, illustrated description of the Meissner drill, which is introduced by the Siemens & Halske Company. The motor is separate from the drill itself, being connected to it by means of a flexible shaft; in this way a light, high-speed motor may be used. The flexible shaft turns a small fly-wheel attached to the drill, which imparts the necessary reciprocating motion to the drill rod by "any well-known means."—"Eng. and Min. Jour.," Dec. 24.

Polyphase Transmission of Power.—A reprint of the article abstracted in the "Digest" last week.—Wallis. "El'ty," Dec. 28.

Transmission of Power in Mining.—A reprint of the abstract noticed in the "Digest" Dec. 10.—Esson. "El'ty," Dec. 28.

Traction.

ELECTRIC TRACTION FOR HEAVY RAILROAD WORK.

The beginning of an article describing the road which is to be constructed from Berlin to Zehlendorf under the direction of the Prussian Government as an experimental line, on the results of which the use of electricity in place of steam on some of the other railroads is to depend. The data is taken from a paper by Bork (see "Glaser's Annalen," Vol. 29, p. 223, 34, p. 6, 43, p. 73), before the German Railroad Association. The total length of the line is 11.98 km (about 7 miles), and there are four intermediate stations; with the exception of a grade near Berlin, there are to be few grades and curves. The electrically operated train is to be run one year according to the regular schedule of the Wannsee Railroad, of which it forms a part; fifteen trips are to be made daily in each direction. The train will consist of nine standard, three axle cars, the total weight of which when loaded is 210 tons. All of the cars are provided with an air brake, the air being compressed by electric motors; they are to be heated by steam. Only the first and last cars will have motors, besides also carrying passengers. The power developed at starting will be 240 horse-power, and the mean power during transit 140 horse-power. Each motor-car will have two motors of 100 horse-power, one on the front and one on the rear axle, but only those on the leading motor-car will be used after the train has been accelerated; the capacity of the motors is therefore appreciably higher than the estimated work which will be required of them. At normal speed the drawbar-pull will be 950 kg, while at starting it will be 3250 kg. The connections for the nine points in the controller are illustrated in the abstract from which this data is taken.—"Zeit. fuer Elek.," Dec. 11.

ELECTRIC LOCOMOTIVE.

A brief account of the locomotive with which experiments are being made under the direction of Baudry on the railroad from Paris to Lyons. The locomotive was constructed at the works of that company. It contains two motors, one on each axle, having a total power of 611 horse-power; the motors can stand 700 amperes and have a speed of 500 revolutions per minute. Behind the locomotive is a tender containing 192 accumulators; the locomotive itself also contains 18 accumulators for operating it when it is detached from its tender. The first trial was made on Nov. 6, 1897, and since then experiments have been made weekly, the design of the present locomotive being based on the experiences thus gained. It weighs 44,500 kg, and has exerted a drawbar pull of 147,000 kg at a speed of 45 km per hour, or 100,000 kg at a speed of 100 km per hour. Without appreciably increasing the weight of the locomotive, and by using four motors instead of two, the new locomotive will have a drawbar pull of 200,000 kg at a speed of 100 km per hour (60 miles). The results are said to have been very satisfactory; a recent test was made in the presence of a number of the officials. The objection to carrying the heavy weight of the accumulators will be overcome by the use of the usual third rail. The complete report on the experiments, it appears, will soon be published. The abstract from which this was taken contains no further information.—"L'Elec.," Dec. 17.

LAUSANNE TRAMWAY.

An illustrated and well-written description of the system of electric railways in that city in Switzerland, which is of interest on account of the exceptionally steep grades and other special features; it appears to be the most complete description of those lines which has been published, and contains much engineering data. The total length of the lines is 8.4 miles, only 5 per cent. of which is on the level, and 2 per cent. is on grades steeper than 11 per cent.; sharp curves of 66 feet radius coincide at many points with steep grades of 6 to 8 per cent.; the sharpest curve has a radius of 28 feet. The power is generated by gas engines directly coupled with the dynamos, each gas engine developing 150 horse-power; in addition there is a storage battery of 300 cells. Each car is equipped with two motors of 20 horse-power. The working results are given in a table; there was an eminently satisfactory result even from the first year's working.—Preller. Lond. "Engineering," Dec. 16.

CITY AND SOUTH LONDON RAILWAY.

A brief, illustrated description of the extensions which are at present being made in this underground electric railway in London. The line is being carried under the bed of the river Thames, and a station is being constructed underneath one of the city churches. Thirteen years have now elapsed since the construction of this railway first began; financially it has not been a conspicuous success, as the dividends have never reached more than 2 per cent.; the percentage of working expenses to receipts for the first six months of 1897 was 57.2; with the new extensions a considerable increase of traffic is expected. The illustrations include two views of the interior of the generating station, and several views of the tunnels, which are driven by means of the Greathead system. Electricity is used largely in the work of construction.—Lond. "Elec. Rev.," Dec. 16.

REFERENCES.

Electric Canal Traction.—In this continuation of that translation which was noticed in the "Digest" last week, brief descriptions are given of the systems in use, accompanied by some of the data.—Lond. "Elec. Rev.," Dec. 16.

Railroad Extension into Paris.—A brief description of the extension of the Orleans steam railway into the heart of Paris, on which extension electric traction will be used.—"L'Ind. Elec.," Dec. 10.

Depreciation of Street Railway Equipment.—A table based on the experience of the Chicago City Railroad Company by its chief engineer and giving the depreciation in per cent. per year of the various parts of the equipment. For the armatures and the commutators the figure is 33 per cent.; for the "insulation" of the line, 12 per cent.; for the cables of the cable machinery, 175 per cent.; the lowest is for generators, 3 per cent.; for bonding it is 8 per cent., and for the trolley wire, 5 per cent.—Knox. "St. Ry. Rev.," Dec. 15.

Railway Mileage in Foreign and American Cities.—A reprint of a short article on the cost of operating trolley lines, including a table giving the ratio of the mileage to the population in a number of cities in Great Britain and America, as also in Berlin and Paris. These figures, for the American cities, average about 1500 inhabitants per mile of track, while in England they vary from 10,000 to 50,000; in Berlin it is 10,000 and in Paris 13,587.—"St. Ry. Rev.," Dec. 15; reprinted from the Lond. "Surveyor."

Harvard Power Station.—Tabulated results from the elaborate test of the steam engines at the Harvard power station of the Boston Elevated Railway, made by the students of the Massachusetts Institute of Technology, a full report of which was published in the "Technological Quarterly" of Sept.—"St. Ry. Rev.," Dec. 15.

Electric Traction.—An abstract of the long reports by Ziffer to the Permanent International Tramway Union Convention, held at Geneva in August. It is on recent progress in the various systems of mechanical traction for tramways. The present abstract contains the general conclusions.—"St. Ry. Rev.," Dec. 15.

Electric Street Railroads in England.—A long abstract of a consular report, referring chiefly to the electric railways in Liverpool and London.—Boyle. "West Elec.," Dec. 24.

Conduit and Accumulator Systems.—Reprint of some English opinions on the relative advantages of the two systems for street railways.—"St. Ry. Rev.," Dec. 15.

Motor-Cab Competitions.—A brief description of the vehicles and some of the conclusions arrived at in the recent competition in Paris.—"Eng. News," Dec. 22.

Detroit-Ann Arbor Railway.—A brief, illustrated description of this 40-mile interurban electric railway.—"Elec. Eng.," Dec. 22.

Installations, Systems and Appliances.

REFERENCES.

Central Station Costs.—Several of the English electrical journals publish weekly statistics and analyses of the cost of operation of central stations in that country. These will not be noticed separately in the "Digest." The Lond. "Electrician" publishes each week an analysis of the accounts of two selected stations, together with a convenient list of those previously published. Lond. "Lightning," also a weekly, publishes each week a well-filled table of costs of stations in the United Kingdom, as also an analysis with comments of special ones.

Brighton Break-Down.—The lengthy discussion of this subject is being continued. Quin, in the Lond. "Elec.," Dec. 16, suggests exciting the fields separately by independent sources and not by a common exciter or storage battery. The Lond. "Elec. Rev." also contains several communications, apparently of no great importance.

Christiania.—In the continuation of the description of the former Schuckert works, a description is given of the plant at Christiania, which was installed by that company. It includes good working drawings of one of the 400-kw generators; also an illustration of a cut-out and a junction box.—Lond. "Engineering," Dec. 16.

Methods of Charging.—A recent paper before the International Society on rational system of charging. It seems to be similar to the article which that author published about a year ago in the latter journal.—Pellissier. "Bul. Soc. Int.," Nov.; abstracted in "L'Eclairage Elec.," Nov. 26.

Commercial and Business Aspects of Municipal Electric Supply.—In this continuation of this long series the author discusses the hiring out of motors, arc lamps, and other apparatus.—Gibbings. Lond. "Elec.," Dec. 16.

Voltage Regulation in Three-Phase Circuits.—A long abstract of the article noticed in the "Digest" Nov. 26.—Del Proposto. "Elek. Zeit.," Dec. 8.

Duesseldorf.—Extracts from the reports of the operation of this station for the year ending last March.—"Elek. Zeit.," Dec. 1.

English Practice.—Brief, illustrated descriptions of the power station at Glasgow of the Middlesbrough Railway and of the Llandudno and the Belfast lighting stations.—"Elec. Eng.," Dec. 22.

Wires, Wiring and Conduits.

ALTERNATING-CURRENT CABLES.

A short article in which he describes a method for increasing the capacity of concentric cables, for the purpose of compensating for the phase-shifting between the current and voltage. This phase-shifting is, as is well known, caused largely by the inductive loads, chiefly by motors and the coils of arc lamps, and means that the generators and wires must be made larger. Instead of adding condensers, as some makers do, the present author shows the advantage of increasing the capacity of given concentric cables. This is accomplished by connecting the cables in a different way. Usually concentric cables are connected with their inner wires together and their outer wires together, but in the present system the inner wire of one cable is connected with the outer of the other, the inner of which is connected to the outer of the first, and in this way he shows that the capacity is considerably increased. Referring to the first

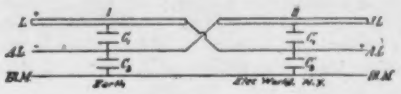


FIG. 1.

of the adjoining figures, the cross-connections are shown, *J L* being the inner wire and represented by a double line, *A L* the outer wire and *B M* the lead armor, which is earthed; the capacities are shown diagrammatically by means of small condensers. The capacity between the + wire and the — wire is equal to the sum of that of the two upper condensers increased by the resulting capacity of the two lower ones connected in series. In the second illustra-

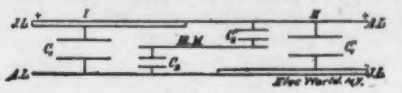


FIG. 2.

tion the same arrangement is drawn in a different way, showing the two condensers in series more plainly. A formula for the total capacity is given; it is simply the sum of the capacities of the two upper condensers in the first figure, plus the reciprocal of the sum of the reciprocals of the other two. This was confirmed by experiments in which it was found that the capacity thus connected was 0.372 microfarads, while connected in the ordinary way it was only 0.226, the former being, therefore, an increase of about 60 per cent. This would become still higher if the cable were constructed with reference to its capacity. It would be of advantage to connect equal lengths of the cables in this way instead of merely connecting the lead and return by this method, as the charging currents which flow through the lead armor would then have shorter paths and would not give rise to earth currents. Moreover, the voltage between the conductor and the earth will then be the same, namely, equal to half the voltage of the generator for both the lead and the return wire, while in the ordinary method of connecting concentric cables the voltage of the inner wire toward the earth is equal to that of the generator. Moreover, in the calculation of a capacity it is not necessary to consider that between the two lower condensers in the first figure the lead armor has an earth potential, nor will it have any effect if the two capacities of those condensers are different; the voltage between the conductors and the lead will remain the same even when the lead armor is insulated from the earth.—Andriessen. "Elek. Zeit.," Dec. 15.

CONCENTRIC WIRING.

An editorial discussion. Since the introduction of pressures from 200 to 250 volts it has become usual to connect the middle of a three-wire system to earth; although formerly forbidden by the Board of Trade, it is now strongly recommended by it. In the usual concentric wiring all the fuses and switches are on an insulated conductor, which is entirely enclosed by another, which serves as a protector and at the same time as an uninsulated return, its continuity being preserved throughout from the caps of the lamps to the switchboard; the switches and fuse-holders have not only metal covers, but also metal bases, forming part of the return circuit. The chief advantage of this system is thought to be that it permits of no half measures as far as faults are concerned; leakages to earth and from wire to wire are the same thing; the number of fuses required, and hence the number of extinctions due to bad fuses is diminished by a half; the design of lamp sockets and holders is improved; the mechanically weak porcelain is replaced by metal in the bases of fittings. It is thought, however, that the present double-wiring system is safe enough and good enough, and that the advantage of the other does not justify an appreciable increase in the cost; it is not thought to be as cheap as or cheaper than the iron-tube and wooden casing system, when a fair comparison is made; but if it is to be more widely used, so that it may become cheaper, it is thought that it will be able to compete on an equal footing, as regards cost, with the more popular methods. With the ordinary system a voltage higher than 250 above the earth would be associated with danger to persons; with concentric wiring, however, the chance of receiving a shock is very minute. When higher potentials than 250 volts are allowed within buildings, it will probably be after a general introduction of concentric wiring. An important question to be settled is where the earth connection is to be. The only town in which concentric wiring has been exclusively adopted in Guildford, and there there is no direct earthing at all, the distributers being insulated from earth up to the house terminals, but within the house the outer conductors are bare; the voltage is 200 on each side. The plant is a small one, as there are only seventy-two consumers, and it has been in operation for only two years. It is thought that it would be better to make a good earth at the feeding points. One

objection to the system is that if it is earthed throughout no insulation test during supply can be made except, perhaps, in the case of feeders, and a defect is not noticed until it becomes a short circuit. —Lond. "Elec.," Dec. 16.

RELATIVE COSTS OF COPPER AND ALUMINUM.

A short article supplementary to the one by the same author noticed in the "Digest" Sept. 24, and replying to some of the subsequent criticisms ("Digest," Oct. 1 and 15). The figures are corrected for the recent rise of nearly $22 per ton in the price of copper; this gives as the ratio of copper to aluminum 100 to 125, and therefore, in spite of the rise of over 8 per cent. in the price of copper, it is still one-fourth more costly for bare conductors of equal length and equal resistance. The author claims that the price of aluminum quoted by the Pittsburg Reduction Company in bar or rod form, namely, 29 cents per pound, is below the actual cost of production, and is only fixed for the purpose of inducing electricians to make a trial of aluminum as a conductor. The transmission line from Snoqualmie Falls to Seattle, a distance of 34 miles, will require 150,000 pounds of aluminum. Concerning the influence of the purity of the aluminum on the conductivity he refers to the recent paper of Richards and Thomson in the "Jour. of the Frank. Inst.," April, 1897, who found that while 99.75 per cent. aluminum has conductivity between 63 and 64, copper being 100, aluminum of 99 per cent. has a conductivity only of 59. For the Snoqualmie line it will be below 59, since the aluminum is to be alloyed with 1.5 per cent of copper, in order to increase the tensile strength. If, therefore, aluminum companies are prepared to sell the metal with a conductivity of 59 at 29 cents per pound, electricians have a metal which, at the present price of copper, is worth considering, although still the dearer of the two, the ratio being 100 to 115. If, however, the price for aluminum is about 32 cents per pound, then copper, in spite of the recent rise, is much the more economical for bare conductors. For covered conductors there can be no question of rivalry between the two until aluminum has fallen to one-half or one-third of its present value.—J. B. C. Kershaw. Lond. "Elec. Rev.," Dec. 16.

Electro-Physics and Magnetism.

GENESIS OF ELECTRIC SPARKS.

Descriptions of experiments made to photograph electric sparks, the results of which elucidate several hitherto doubtful points. The author mounted a rapid plate on a small car moving on rails and driven by a falling weight; this also furnished a measure of the time. All the records agreed in showing several discharges, succeeding each other at intervals of 2.7 x 0.0001 second. "The first discharge was by far the strongest, and the track of the spark showed several branches and brushes. The portion of the spark at the negative pole was always more strongly marked than that at the positive pole, evidently owing to the difference in the actinic powers of the anode and the cathode light. The successive partial discharges, though all in the same direction, show an alternate weakening and strengthening, due to the surgings of the primary current in the condenser. A further analysis of the sparks reveals a process of a more complicated, but highly interesting nature. It is seen that every spark is preceded by several brush discharges. Each brush discharge is separate from the preceding one, which is usually of the opposite sign. Thus a small brush will start from the negative pole, and another shortly afterward from the positive pole. Then a larger brush will start from the negative pole through the path marked out by the first one, and will then bend aside and proceed a step further, and so on until the whole gap is bridged and the first spark passes. When the analysis is not very minute the preliminary brushes appear as appendages to the first spark. Such appendages are also seen in lightning photographs. Lightning flashes are, therefore, probably also preceded by pilot brush discharges."—Walter. "Wied. Ann.," No. 12; abstracted in Lond. "Elec.," Dec. 16.

COHERER.

A discussion, both theoretical and experimental, of the coherer. The author criticises Lodge's theory, showing how it appears to fail. He finds that the action of the coherer is dependent only on the temperature changes, but not on the presence of a high temperature. If, for instance, a coherer is excited when warmed in a water bath, then the resistance, which has thereby been lowered, will assume its original value as soon as the excitation ceases and without other external influences. Experiments which he described show that for every coherer there is a certain critical voltage at which it still reacts; this voltage is smaller the more sensitive the coherer for electrical oscillations. In his tests this critical value in many cases was 0.2 volt. By the application of too high a voltage the coherer loses the property of returning to its original resistance when shaken. He thinks that the phenomenon in the coherer is caused by a sort of electric discharge. Little value can be placed on that fact that especially sensitive coherers will react for accoustic waves, as such coherers are not very stable mechanically and are more easily affected by mechanical actions.—Aschkinass. "Wied. Ann.," 66, p. 284; abstracted, with some illustrations, in the "Elek. Zeit.," Dec. 15.

ROENTGEN RAY BURNS.

A brief abstract of the proceedings of the recent meeting of the Roentgen Society, which was devoted entirely to the discussion of the important question of "Dermatites in Relation to X-Ray Work," including two short papers by Walsh and Payne, and a discussion. The general conclusions arrived at were: "(a) that highly exhausted focus tubes are less liable to produce X-ray burning than are 'soft' tubes; (b) that the ill effects of the rays are perverted by a layer of clothing; (c) that the actual cause of the burning (so-called) is still uncertain, and may be due to either the heat emitted by the tube when in action, the cathode rays, the X-rays, or by the brush discharges taking place at the terminals of the focus tube. Dr. Holland, of Liverpool, reported some very interesting experiments in which certain troublesome ulcerous conditions had been apparently completely cured by the application of the X-rays to the affected area. What is thought to be most needed is a properly carried out experimental investigation into the whole subject, a work which might well be undertaken by a committee of that society.—Lond. "Elec.," Dec. 16.

REFERENCES.

Physics.—The monthly journal "Science Abstracts," published in London, contains very good abstracts of articles and papers on the subject of Physics and Electrical Engineering; many of these on physics are of interest also to electrical engineers. Most of those on electrical engineering were noticed earlier in the "Digest," though often more briefly; these, as well as those on physics, will not be noticed again in the "Digest." The Lond. "Electrician" publishes each week very good abstracts by E. E. Fournier d'Albe of the more important articles on electro-physics, from the leading French, German, Italian and English scientific journals. Those belonging more to the subject of physics rather than electrical engineering will not be noticed in the "Digest," unless of exceptional interest.

Conductivity of Potassium Nitrate.—An article giving the results of what appear to have been very extended researches to determine the conductivity of potassium nitrate for all concentrations from 5 per cent. to the anhydride, and all allowable temperature intervals up to 370° C.—Kramers. "Arch. Neerland des Sciences Exactes et Nat.," 1, p. 455; noticed briefly, with the final formula, in "Zeit. f. Elektrochemie," Dec. 15.

Stratified Brush Discharge.—By inserting in the circuit a spark gap and a large liquid resistance, the capacity being small, the author obtains stratification in the brush discharge in air. This is considered another bridge across the gulf that divides the phenomena of electrical discharge in the open air and vacuum respectively. —Toepler. "Wied. Ann.," No. 12; abstracted in Lond. "Elec.," Dec. 9.

Currents in Intermediate Conductors.—When one conductor is contained in another, an electric current will in general flow through the former also, as, for instance, when a conductor is placed in an electrolyte. This the author discusses theoretically and with the aid of a number of experiments.—Stark. "Wied. Ann.," 66, p. 245; abstracted in "Elek. Zeit.," Dec. 15.

Photography of Coherer Sparks.—The author obtained further evidence that the change of resistance in coherers is due to sparks between the particles. The photographs of the sparks in a thin layer of powder placed over the sensitive plate.—Maglagoli. "Nuovo Cimento," Aug.; noticed briefly in Lond. "Elec.," Dec. 9.

Effect of Heat and Humidity on the Resistance of Insulating Materials.—An abstract of the results of a series of tests made by Chester and Crellin at the University of Illinois, made to determine the effect which heat and humidity have on the ohmic resistance of insulating materials.—"L'Eclairage Elec.," Dec. 10.

Electro-Chemistry and Batteries.

COMPETITIVE TESTS OF AUTOMOBILE ACCUMULATORS.

A reprint of the programme of the competitive tests which are to be made by the Automobile Club of France, of accumulators intended for such vehicles. The trials are to begin on the second Monday in April, 1899. Tests will be made of the life of the batteries, their commercial efficiency, of the frequency, importance and ease of the operations required for their maintenance, and of the watts compared with the capacities. Each battery must not weigh more than 110 kg (242 pounds), not including the box containing the cells; the battery must furnish 120 ampere hours at a constant output of 24 amperes during five hours without falling in voltage (on closed circuit) below 8.5. (From this it would appear that of the usual lead accumulators about five cells are required for the test, as this voltage then corresponds to 1.7 per cell; it is no doubt stated in this way in order to include other kinds of accumulators also.) The charge will be completed in eight hours at a maximum with the batteries in series, and with a decreasing current the initial value of which will not be less than 30 amperes and the final value about 15; the charge will be stopped when requested by the representative of the battery. During five days of the week the batteries will be submitted for five hours to mechanical movements analogous to those to which they would be subjected on vehicles, and during that time they will be discharged at variable intensities, according to a schedule given, in which the maximum current for a short time will be 100 amperes; for a somewhat longer time, 70, and for the large portion of the time, 40, 30 and 20, including also a period of rest of ten minutes, the whole discharge continuing twenty minutes. The output during each of these intermittent discharges will be about 12 ampere hours.—"L'Ind. Elec.," Dec. 10.

SULPHIDE ORE PROCESS.

A brief description of the Swinburne process, which may soon be worked experimentally. "The crushed but unroasted sulphide ore is fed into an externally heated cauldron, containing molten lead

and molten zinc chloride. The silver of the ore alloys with the lead; the zinc and lead sulphides mix with the zinc chloride, and form a molten mixture of chlorides and sulphides. After removal of the lead-silver alloy the molten mass is electrolyzed, and first the lead and then the zinc obtained in molten form at the cathode, while sulphur escapes as vapor at the anode. No chlorine is liberated, and the zinc chloride is finally recovered from the gangue, etc., of the original ore by distillation. Owing to the metals being separated at a temperature above their melting points, no difficulties arising from spongy deposits occur." The cost of operating the process is estimated at $9.50 per ton of ore in Australia, or $0.25 per ton if only the silver and lead are to be extracted. Editorially it is questioned whether he had considered the time required to deposit the whole of the lead, as such operations are difficult in practice; if the zinc sulphide is to be entirely free from lead sulphide, the cost of recovering the lead will be much higher per ton than is estimated, and if not completely separated the zinc will be alloyed with lead and therefore unfit for many purposes. Nevertheless, the process is thought to be a promising one.—Lond. "Elec. Rev.," Dec. 16.

PURIFYING WATER BY OZONE.

A translation of an article from a French journal describing the Tindal system, which has frequently been referred to in the "Digest."—"Elty," Dec. 28.

REFERENCES.

Electrochemistry.—The German journal, "Zeitschrift fuer Elektrochemie," published weekly, contains good abstracts of patents on electrochemical processes, apparatus, batteries, etc., not only of German patents, but also of the English and American. These abstracts will not be noticed again in the "Digest."

Crystallized Tungsten by Electrolysis.—A brief description of this process, in which the crystallized metal is obtained from the tungstate of lithium.—Hallopeau. "L'Eclairage Elec.," Dec. 3; "L'Ind. Elec.," Dec. 10.

Zinc from the Chloride.—A translation in full of the article noticed in the "Digest" Aug. 6.—Foerster and Guenther. "L'Eclairage Elec.," Dec. 3.

Progress in Electro-Chemistry.—The beginning of a summary of the progress made during the year 1897.—"Elek. Anz.," Dec. 8.

Units, Measurements and Instruments.

NEW THERMOPILE.

The author used one of constantan and iron giving 53 millivolts per centigrade degree, instead of the usual couple of antimony and bismuth, which metals are difficult to work. He moreover used very thin wires in order to diminish the heat capacity. With one of these he obtained a sensitiveness of 0.00106 volt per degree centigrade, with an internal resistance of 3.5 ohm, and it was therefore possible to use a very sensitive galvanometer, so that temperatures of less than a millionth of a degree can be determined very accurately.—Rubens. "Zeit. Phys. Chem.," May; noticed briefly in the "Zeit. f. Elektrochemie," Dec. 15.

REFERENCES.

Mutual Action of Two Circuits and the Determination of Dielectric Constants.—The author develops theoretically the mutual action of two circuits carrying currents, if the one consists of a condenser, a spark micrometer and a coil of a few windings, the other of a coil of many windings, a condenser and a coil indicating the current; the condenser in the primary circuit is charged from an influence machine. By changing the dielectric the method may be used for measuring the dielectric constant, but it cannot be applied to materials which have a great absorptive power, as damping introduces a very large error. In the abstract a table is reproduced, giving the values found in a number of different cases.—Erskine. "Wied. Ann.," 66, p. 268; abstracted in the "Elek. Zeit.," Dec. 15.

Hour Meter.—A long, illustrated description of the Cauderay multiple hour meter, which is intended for those cases in which the energy is paid for according to the length of time that the lamps are burning, but irrespective of their number. It differs from the usual hour meters in that it is arranged for a number of circuits, although containing only one clockwork; this will run twice as fast when lamps are used on two circuits, for instance; an integrator sums up the total time. It is therefore, in effect, a combination of a number of hour meters.—Aliamet. "L'Elec.," Dec. 17.

Measuring Instruments.—A brief, illustrated description of those made by Gans and Goldschmidt. They are of the d'Arsonval type, like the Weston. It is claimed that their permanent magnets will not alter if the air space is made very small; these instruments are therefore provided with wrought-iron pole pieces and a wrought-iron core inside of the coil. A sensitive galvanometer on this principle, with removable suspension system, is also shown.—"Elek. Zeit.," Dec. 15.

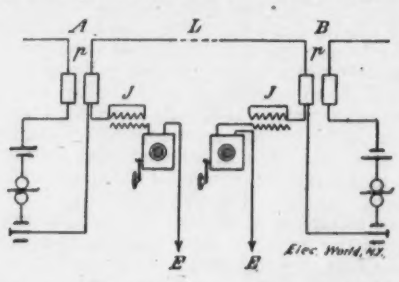
Telegraphy, Telephony and Signals.

MAGNETIC SPACE TELEGRAPHY.

The beginning of a reprint of an Institution paper. The first part consists of a recapitulation of the three chief methods which have been tried; first and oldest, the earth current or leakage method, which he thinks is destined to play a more important part in future than is generally thought; the second is the method of magnetic induction between two insulated wires parallel to one another, or what is known as Preece's method, and this is the only one in actual, regular use; the third is by Hertzian waves; in connection with the latter the author explains at some length wherein this method differs from the second one. He then begins the description of his so-called magnetic method; he admits that the method contains nothing new in principle and involves no discovery, but it has been successful over small distances, and is practical for long distances. The chief feature is the outcome of an electric resonance experiment, which he described eight years ago, namely, that of the syntonic Leyden jars. He prefers to use the word syntony in place of resonance for denoting the sympathetic response between two vibrators tuned to the same frequency. Two similar Leyden jars connected to similar circuits may be thus syntonized, and any electric oscillations in one will cause feebler oscillations in the other, the medium of communication being the alternating magnetic field between the two circuits; the induced voltage may rise as high as several thousand volts, causing a spark over a very considerable air gap. For photographic purposes he uses condensers of considerable capacity, and the circuit of the condenser becomes a large horizontal coil of wire of one or more turns; the frequency, instead of being in the millions per second, becomes thousands, or even hundreds, per second, which is appropriate to sound, and therefore, instead of using a spark gap as a detector, he uses either a coherer or a telephone in shunt to the receiving condenser. As a sounder he uses an alternator of considerable power. At his house is a cable a quarter of a mile long, enclosing a rectangle of 150 x 30 square yards, and with this he can hear all that goes on in the neighboring telephone wires, and is even able to answer back with a suitable transmitter. The sending coil is a similar one about two miles distant. He has also tried to operate the system without condensers, but it was not very successful; through empty spaces the signals become audible at two miles, only when a condenser was used. He operated with the third harmonic of the alternating current, thus using a frequency of 384, as the ear is more sensitive to this higher note; the condensers had a capacity of 28 microfarads. He generally used two Ader telephones in series, each of about 70 ohms resistance, and connected them as a shunt to the receiving condenser; the resistance of the receiving cable was only 0.07 ohm. At the sending end condensers were also used, and were connected in series with the dynamo and coil in order to strengthen the third harmonic at the expense of the fundamental. The cable contained twenty strands, which were connected in five series of four strands each, the current being 6 amperes. He then begins the elementary theory of magnetic induction telegraphy, both without and with condensers. He shows that no unaided (meaning without condensers) simple induction process can work satisfactorily over really large distances unless a prohibitive amount of wire or an extravagant amount of power is used. One of his formulas shows that in the unaided system a high frequency is a disadvantage, other things being equal; that a single contour is much better than a coil of many turns; also that the product of the linear dimensions of the coils is incompetent to cancel the cube of the distance in the denominator of the fraction when both wire and distance are increased in the same proportion; this is based on a given e. m. f. and not on a given current; increasing the thickness of the wire is of no advantage. A given length of wire is best disposed in equal contours of one turn each. To signal double the distance two times the square-root of two times the length of wire is necessary; to signal ten times the distance it must be increased 32-fold, the thickness being increased at the same time. He then discusses the introduction of condensers and shows that when these are introduced and properly tuned the conditions are greatly altered. When the correct note is reached all self-induction is abolished and the impedance becomes simply resistance. High frequency is then especially advantageous; the number of turns is immaterial, which is often convenient for tuning. The reprint is to be continued.—Lodge. Lond. "Elec." and "Elec. Eng.," Dec. 16.

TELEPHONES ON TELEGRAPH CIRCUITS.

A short description of a method of connecting telephones on existing telegraph lines so that neither interferes with the other, and both may be used simultaneously; this, it is claimed, is of use in special cases. The arrangement is shown in the adjoining figure. The



telephone apparatus must in such cases be connected to the other circuit without a switch, in order to prevent the possibility of the telegraph line being left open accidentally. This is accomplished by means of an induction coil, as shown, similar to the well-known Langdon-Davies phonopore. The author has used the present system repeatedly, with very satisfactory results. The diagram shows two neighboring telegraph stations, of which *p p* are the plates of the lightning arresters; the telephones are connected to two of these, as shown, through an induction coil, one coil of which had its ends connected by a wire, while one end of the other is left insulated, the other being connected through the telephone to ground; the connections must be so made that when the telephone is hung up its circuit is insulated, and the only operation of the switch,

therefore, is to disconnect the earth circuit. The object of this appears to be to protect it against lightning currents. The arrangement of the induction coil increases the condenser action appreciably. As the telephone circuit is not a shunt to the telegraph circuit, it will not be affected by the telegraph signals, and both may be used simultaneously, for although the Morse signals will be heard in the telephone, the speech-transmission is so good that it will not interfere. The call can be a certain signal on the telegraph circuit.—Canter. "Elek. Zeit.," Dec. 15.

TRANSATLANTIC TELEPHONY.

Transatlantic Telephony.—A brief description of the system recently proposed by Edison in a daily paper. It consists simply in establishing floating relay stations across the ocean in the form of anchored ships, which are connected by cable. The proposition is therefore not a new one. It is estimated that sixty-six of these vessels would be required. The cost alone seems to be prohibitive. —"El'ty," Dec. 28.

REFERENCES.

Telegraph and Telephone Statistics.—The "Journal Télégraphique," published monthly in Berne, Switzerland, contains the most complete telegraph and telephone statistics for most of the countries outside of the United States; they are usually official. These will not be noticed again individually in the "Digest."

Intercommunication in Railway Trains.—The beginning of a reprint of an illustrated Institution paper. The first portion is historical, and gives brief descriptions of the various electrical systems. He discusses and describes the method of connecting the vehicles electrically and the means for indicating the alarm. Illustrations of various couplings and devices are given, with special reference to his own system. He does not favor the use of an earth or rail return. The system is specially adapted for the style of coaches used in that country.—Langdon. Lond. "Elec. Eng.," Dec. 16.

Ultra-Violet-Light Telegraphy.—A translation in abstract of the article noticed in the "Digest" last week.—Zickler. Lond. "Elec.," Dec. 10.

Telephone Patents.—"Electrical Engineering," published monthly, contains an illustrated digest of patents on telephones and kindred matter, prepared by Clement.

Miscellaneous.

LIGHTNING AND LIGHTNING ARRESTERS.

A long abstract of a recent lecture before the Franklin Institute. Concerning the question whether the lightning rod is to be considered a reasonable precaution, the author states that for some reasons it is, as it gives comfort to nervous people, and there is no evidence that it does any harm; but aside from this, he believes that with some few exceptions it does not pay. The well-to-do people have concluded that the danger does not warrant the expense; lightning rods are found more especially on the buildings of the poorer and more ignorant classes. He quotes some statistics, showing that less than 100 dwellings a year are struck by lightning out of millions in this country, and he therefore does not consider that there is sufficient ground for the erection of lightning rods. Other statistics are given, showing that the figures are not alarming; taking the maximum figure for five years, in 1894, 336 people were killed by lightning out of the 70,000,000 in the United States, and he suggests that there is more danger from the air we breathe and the water we drink than from lightning; there are hundreds of other dangers far more dangerous than lightning, and against which we do not take precautions and do not need to take them. Out of 324 strokes only two struck lightning rods, and therefore the lightning rod is hardly a reasonable precaution. Nevertheless, lightning rods are of undoubted value in certain places; he considers them advisable on all buildings of prominence, churches, tall brick chimneys, etc., but otherwise in cities the danger does not warrant their use. In the country it is undoubtedly well to protect barns, churches, and exposed trees. It is often claimed that a rod will protect an area of a radius equal to the height of the rod, but experience has frequently shown that this is not true; several instances are quoted. An observation of the phenomenon of fire balls is described. Considerable damage is done to electrical apparatus by atmospheric electricity, and lightning arresters are used here as a protection. When the electrostatic field in the atmosphere is suddenly removed it causes electrostatic surgings in all electrical conductors, as well as static charges, and it is for this reason that iron articles are frequently seen to spark during a thunderstorm. It is this static charge which damages electrical apparatus by perforating the insulation, and the object of the arrester is to conduct this to earth. He then describes the well-known functions of such arresters, and showed by means of experiments their respective characteristics and resistance to disruptive discharges.—Wurts. "St. Ry. Rev.," Dec. 15.

REFERENCES.

New Austrian Patent Law.—Extracts of the most important parts of the new law, which is to take effect on Jan. 1, 1899.—"Elek. Zeit.," Dec. 15.

Purdue University.—A number of illustrations, accompanied by a brief description, of electrical laboratories of that university.—"Elec. Rev.," Dec. 28.

The Digest for 1898.—During the past year the number of journals abstracted in this department was 1789, averaging nearly 34 per issue; of these 945 were foreign and 844 American. The number of abstracts and references was 4342, averaging 82 per issue; last year the total number was 4169, showing a considerable increase. The largest number in one group was 845, under Electro-Physics and Magnetism; next comes Traction with 567, followed by Electro-Chemistry and Batteries with 496.

New Book.

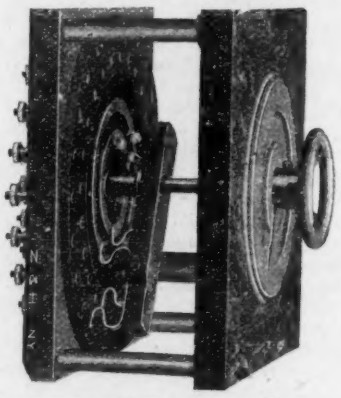
FOWLER'S "MECHANICAL ENGINEER" POCKET BOOK for 1899 is the title of an engineering reference work edited by William H. Fowler and published by the Scientific Publishing Company, Manchester, England. It contains a vast amount of information in all the engineering branches in the form of tables, formulæ, etc. Considerable space is given to the subject of gas and oil engines, and electricity forms a very important part of the book. The subjects of chemistry, fuels, metallurgy, mining, hydraulics, building boilers, etc., are covered, and the data on all these are in a form most convenient for reference. A diary, with a space for each day of the year, is given at the back of the book, besides several sheets of cross-section paper for graphic records. The price of the book is 1s. 6d., English money.

A Voltmeter and Ground-Detector Switch.

The apparatus illustrated herewith is designed for switchboard use, and is stated to be growing in favor among electrical engineers and contractors, embodying as it does many distinctive features. All the contacts, connections, etc., are mounted on a separate slab of slate, which is located at the back of

Voltmeter Switch.

the switchboard. From this slab a rod passes to the front of the board and has attached to it the switch-operating handle, which carries an indicating pointer over a suitably lettered dial-plate. The parts of this switch are susceptible of the finest adjustment by nuts and screws especially provided for the purpose before or after the switch is placed in position. The main points of the design of the switch are clearly shown in the illustration, but the fact is pointed out by the manufacturers, Messrs. Zimdars & Hunt, 127 Fifth Avenue,



Perspective View of the Switch.

New York, that great attention has been paid to details. These switches do not require constant adjusting to keep them in working condition after they have been installed.

The voltmeter switches are regularly made up to twenty circuits, and the differential galvanometer switches up to eight pairs of circuits. They are made of greater range upon special order. Messrs. Zimdars & Hunt will be pleased to answer inquiries and to give further information regarding this apparatus.

An Improved Dry Battery.

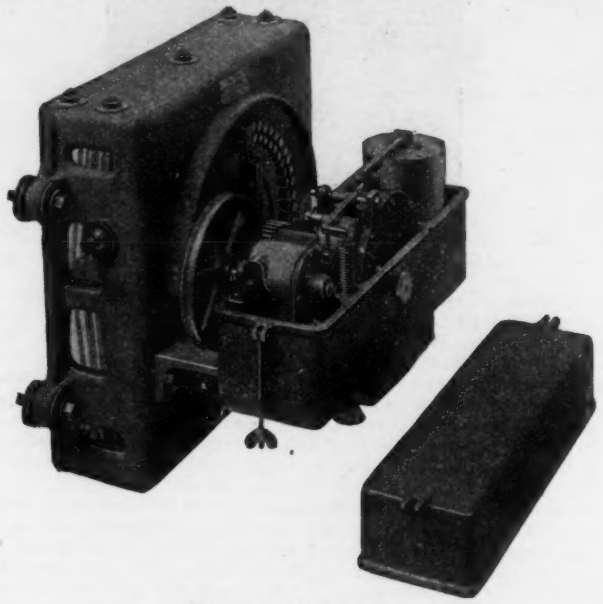
Col. S. G. Booker, superintendent of the Phœnix Carbon Manufacturing Company, St. Louis, Mo., has made application for a patent on a dry battery which, it is claimed, embodies improvements over existing types. The principal object of the invention is to obtain long life. Mr. Booker accomplishes this by using a containing vessel whose walls are sufficiently porous to allow moisture from the atmosphere to pass through them, and a filling having in close asso-

ciation with the exciting material a material capable of absorbing moisture from the atmosphere. He makes the porous containing cell of carbon, utilizing it as the negative element. Inside of the vessel is placed a gelatinous or semi-solid filling containing an exciting material, such as sal ammoniac, and also a material capable of absorbing moisture, such as chloride of calcium. These materials are intimately associated in the mass, so that any moisture absorbed by the chloride of lime or calcium will be imparted to the other material of the mixture, and so maintain the entire mass in a moist condition. The positive electrode, which is of zinc, is surrounded by the semi-solid filling, and between the filling and the carbon element is a layer of depolarizing material. The cover of the vessel is also made of carbon, but harder than that used in the containing vessel.

It is stated that tests have shown that a battery constructed in this manner remains active for a much longer period of time than those types of battery which are sealed, the increased life being due to the fact that the chloride of calcium in the filling draws moisture from the atmosphere through the porous walls of the containing vessel and into the semi-solid mass, thereby maintaining the latter in substantially its normal and original condition. The improvement is not limited to the use of chloride of calcium as a moisture-absorbing material, however, since any other substance capable of performing this function may be used with the same results. Neither is the invention limited to the use of a carbon-containing vessel, although this is a desirable feature.

A New Regulator for Brush Arc Machines.

To get a better control of the current strength of the Brush arc machine the General Electric Company has developed a new type of regulator known as "Form 2" for use instead of the magnetic clutch regulator, now generally in



FORM 2.—REGULATOR.

service on such machines. The new instrument, like the old, varies the resistance of the shunt to the series field winding and also adjusts the position of the brushes on the commutator, and is mounted in the same place on the machine, namely, below the commutator and in front of the rheostat in a cast-iron en-

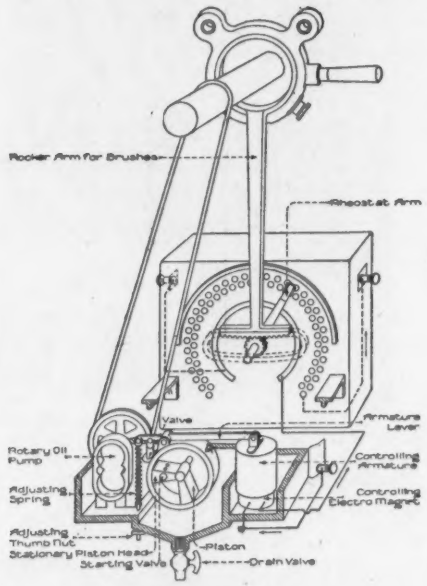
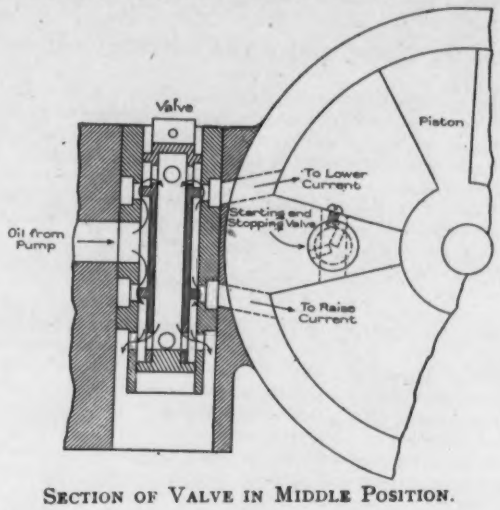


DIAGRAM OF PARTS.

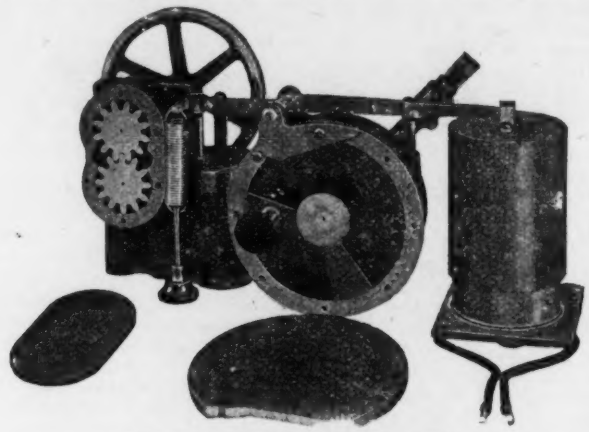
closing case. It requires no wall controller. The mechanism consists of an oil pump driven constantly by a belt from the armature shaft and supplying oil through a two-way valve to a rotary piston or vane, the motion of which is communicated to the rheostat arm and brush-rocking mechanism. The position of the valve is determined solely by the magnetic pull of the main solenoid in the series circuit, the restoring force being the usual spring. With an excess current the valve is displaced in one direction, admitting oil under pres-



SECTION OF VALVE IN MIDDLE POSITION.

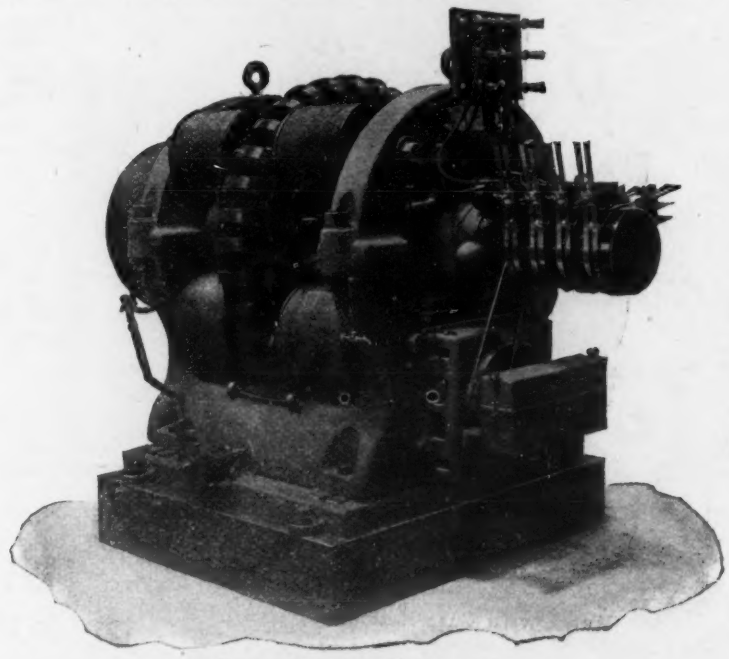
sure to one side of the main vane and allowing it to be discharged from the other side, while with a current less than normal the reverse action takes place. In said position the oil leaks past the valve ports.

The chief advantage of the improved regulator is the fact that the rapidity



REGULATOR WITH CASE REMOVED.

of its motion is to a certain extent dependent on the variation of the current from normal. Thus, in case of a sudden change of load the motion of the regulator is at first rapid, and slows down gradually as normal current is approached. This avoids the hunting or pumping action which occurs with a



MULTIPOLAR ARC GENERATOR.

regulator like the old clutch, which moves at full speed or not at all, and constantly overruns, "hitching" the mechanism back and forth. There are obviously in the new regulator no sparking contacts and few moving parts, the

latter being almost entirely in the enclosing case and partly surrounded by an oil bath. A safety valve is provided to relieve the pump from excessive pressure. The new regulator may be substituted for the former instrument either with or without a new rheostat.

Voltmeter Compensators and Potential Regulators.

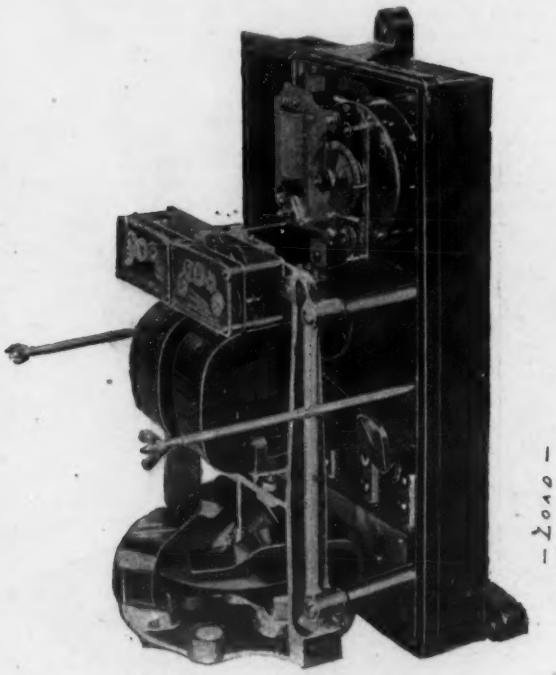
Circular No. 59, issued by the Westinghouse Electric & Manufacturing Company, dated November, 1898, describes a line of instruments for compensating voltmeter indications for line drop put on the market by that company. That designed for non-inductive loads and intended for use in lighting service consists simply of a series transformer with a variable number of turns in both primary and secondary, the primary turns being controlled by a plug with six positions; the secondary, by means of a dial switch. The secondary feeds an auxiliary coil in the voltmeter, which tends to counteract the pull of the shunt coil, which is, as usual, fed from the line by the ordinary instrument transformer. The more elaborate instrument, designed to compensate for both the non-inductive and the inductive drop of the line on what is generally known as the Mershon system, is designed to be used with a separate series transformer. It carries two dials each with two concentric rotating switches, one dial designed to balance out the non-inductive and the other the inductive drop. The switches allow the adjustment of the instrument to the line, one of them inserting between the series transformer and the instrument coil a non-inductive and the other an inductive resistance.

The instruments on the switchboard being automatically corrected to give the voltage at the distant end of the feeder, it becomes necessary to provide some means for delivering to the feeder from the switchboard a voltage higher or lower as the load rises and falls, in order to maintain constant potential at its distant end. This is accomplished with Westinghouse apparatus by means of the Stillwell regulator, described anew in Circular No. 60. The main features of this regulator are well known to the trade, including the reversing switch for boosting up or down and the double-contact finger and preventive resistance for avoiding the short-circuiting of sections between the contacts of the multi-point switch. It is made up when desired in the form of a regulator dial, which may be mounted on the face of the board and connected with the transformer coils at any convenient location. A later type is designed particularly for polyphase circuits. It consists of two face plates with brush-arms and switches mounted in parallel planes, both being operated by a ratchet and pawl movement from one hand-lever. The motion from point to point being made with a quick break, no preventive coil is used. It is encased in a cast-iron frame, with swinging doors on each side.

The circular also describes briefly the equipment of the Carborundum furnaces, described at greater length in other columns of this issue.

Bracket Electric Heaters.

This unique form of electric heater is manufactured by the Girard Electric Heater Company, of Philadelphia, Pa. It is designed for attachment to swing or stationary brackets, and is said to be very desirable for heating large halls, theatres, conservatories, etc. These heaters can be controlled by thermostatic switches in groups so as to keep the room at any given temperature. Another application of these devices is in heating show windows to keep them clear of frost. It is stated by the manufacturer that two cubic feet of air can be heated per watt. The heaters are adapted to any voltage, on either direct or alternating circuits, consuming .9 amperes on 120 volts. With such consumption the temperature of the heating coil is raised to 400 degrees Fahr. The heater is a comparatively small affair, being 2½ inches in diameter by 8 inches in height, and it is finished off attractively. It is placed in a bracket just as an incandescent lamp is attached. It is claimed to be highly efficient, simple and durable.



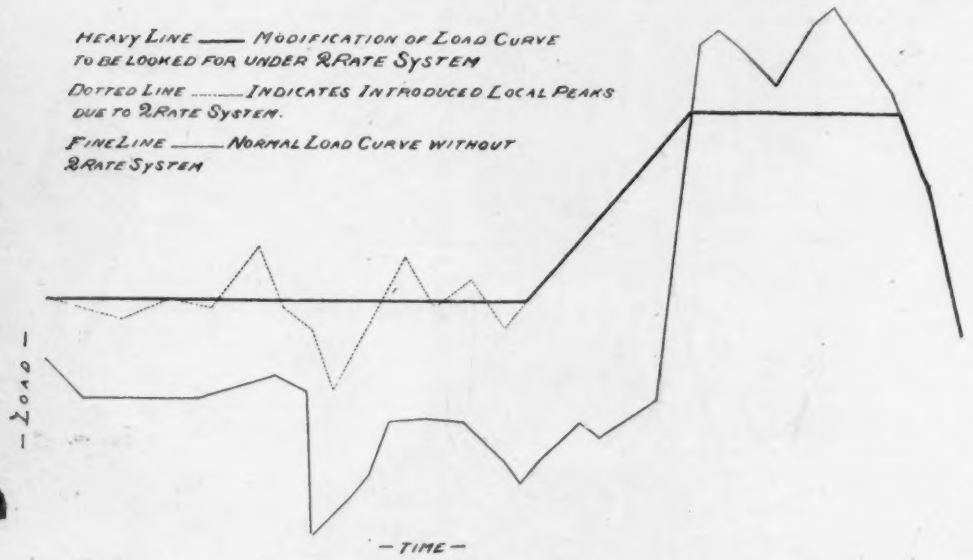
Meter with Case Removed.

A Two-Rate Meter.

Most central stations are now considering the adoption of some sliding scale of tariff. Three of these are now in general use: the first, a system of varying discounts according to the ratio of the lamp hours to number of lamps connected; the second, the use of a maximum recording meter for indicating the maximum load; and the third, two-rate meters, by which the consumer may be charged a higher rate per lamp hour at times when the central station finds it most difficult to meet the demand, and a lower rate at other hours when the station finds it easier to carry the load and desires to encourage the use of current. As between these three systems, the last has the advantages that it is more readily comprehended by the layman and encourages the use of current even with considerable local peaks at all hours except those when the station is heavily loaded. While maximum-demand systems discourage peaks at any time of day, the station manager finds that they are advantageous except during the hours of heavy station load.

Two-Rate Recording Wattmeter Encased.

The General Electric Company has placed on the market a meter, illustrated in the accompanying figures, which is simply a modification of the ordinary Thomson integrating wattmeter, with two dials and an electric or self-winding clock. By means of the latter the mechanical connection of the motor may be changed from one train of gears to the other, and vice versa, at any pre-determined hours of the day. The meter-motor itself rotates at all times with the same speed on the same load, but during a certain period determined by the adjustments of the instrument—during which the station peak prevails—the motor drives through a clutch one of the counting mechanisms, and during the rest of the day the clutch is thrown over by the clock on the other counting train. The central station is thus in a position to learn exactly how much power has been consumed during the hours of maximum demand and how much at other times, and can charge as it pleases, a higher rate for the former and a lower rate for the latter.


HEAVY LINE —— MODIFICATION OF LOAD CURVE TO BE LOOKED FOR UNDER 2 RATE SYSTEM
DOTTED LINE ..... INDICATES INTRODUCED LOCAL PEAKS DUE TO 2 RATE SYSTEM.
FINE LINE —— NORMAL LOAD CURVE WITHOUT 2 RATE SYSTEM
— LOAD —
— TIME —

Estimated Improvement in Load Curves.

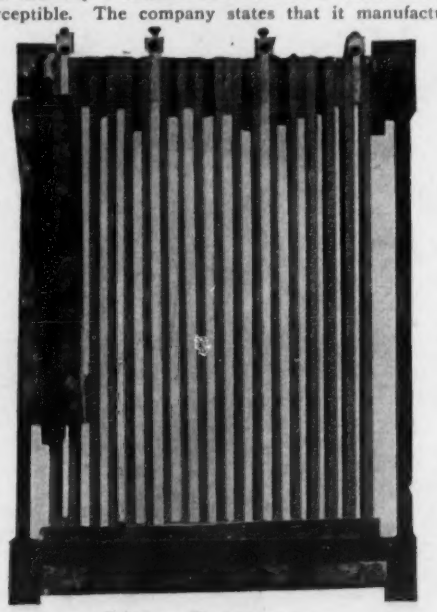
The Raster Carbon Rheostat.

Among the electrical developments of the past year is the carbon rheostat manufactured, owned and controlled by the Raster Carbon Rheostat Company, Chicago. The company claims that it has met with great success, considering that it has been making a hard fight against existing prejudice as to the use of carbon for resistance, and, while there are yet many sceptics, there is no question that the problem has been satisfactorily solved.

The principal features of the Raster carbon rheostat are its extreme sim-

AUTOMATIC RELEASE STARTING BOX.

plicity, its great mechanical strength and its large radiating surface and accessibility. The company states that long and severe use has demonstrated that there is no change in resistance or deterioration of the carbon as manufactured and used by it. It required years of experimental work and close application to obtain a practical method of overcoming all the difficulties in the use of carbon for resistance. In the past experimenters have dealt with the ordinary carbon, commercial compounds or well-known alloys. In its experiments, however, the company found it necessary to develop a carbon compound which was more flexible and of a fibrous structure rather than granular, and at the same time to produce a carbon of even resistance and of uniform conductivity. Plain, smooth surfaces are always essential. After the proper carbon had been found there was yet something more to supply. It was necessary that the terminals and contacts should be of a nature consistent with the carbon, and of such a relation that expansion and contraction in both should be equal, in order to avoid any loss of potential due to poor conductivity at the point of contact. This difficulty the Raster Carbon Company remedied by producing an alloy which, it is stated, remains intact indefinitely. Oxidation, corrosion and electrolytic action are stated to be absolutely avoided in this form of construction. The most severe tests have been applied to these resistances, such as overloading them while immersed in water, but they have withstood them all. The contacts and the carbon, together with the insulating blocks, are held in position under pressure which does not change under the most severe conditions. It is stated that under ordinary conditions the decrease of resistance in these rheostats is not perceptible. The company states that it manufactures when re-



CARBON RESISTANCE.

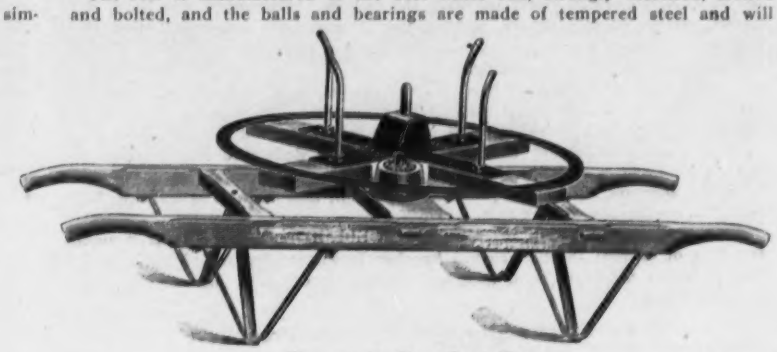
quired a resistance that is absolutely constant. All of its standard resistances, however, are so nearly constant that for all practical purposes no change is noticeable. All of these qualities have been proved after a year's constant service under the most trying conditions. As a further evidence of the reliability of the company's products, it is stated that in one year over 800 resistances, aggregating nearly 4000 horse-power, have been placed upon the market.

The company's automatic release starting boxes are finding much favor in the trade. The Raster Carbon Rheostat Company, in the short space of time in which it has been in business, has sent goods to nearly all parts of the world, some recent shipments having been to Australia and Honolulu. Other have been made to England, France and Germany.

The Dicke Ball-Bearing Pay-Out Reel.

The novel and valuable feature of the pay-out reel, illustrated herewith, is the method of supporting the circular platform upon which the wire is placed. In the illustration two of the cross-arms of the reel are cut away to give a view of the truncated cone, on top of which is a number of small balls. A reel revolves upon these balls, which reduce the friction to a minimum.

The reel is manufactured of the best white oak, strongly mortised, ironed and bolted, and the balls and bearings are made of tempered steel and will



IMPROVED PAY-OUT REEL

stand much use. The Western Electric Company, New York and Chicago, is the exclusive agent for the sale of this reel in the United States.

The "Standard" Indicator.

During these times of competition no subject is of more importance to the engineer and steam user than the economical generation and use of steam, and in this connection no instrument is of more pronounced benefit than the steam engine indicator.

In the "Standard" indicator (Fig. 1), which is manufactured by the Lippincott Steam Specialty Company, 169-171 Broadway, New York, all complicated features have been carefully avoided, but no necessary adjustment has been omitted. The cylinder of the instrument is of the standard bore, 0.7978 of an inch in diameter, to which is carefully fitted a bronze or steel piston. The piston rod is hollow and threaded to receive a swivel rod by means of which the pencil may be raised for use on condensing engines. The same object may be attained even while the indicator is under steam by loosening the clamp screw or the drum-supporting arm, after which this arm may be placed in a different position on the cylinder. This feature also permits turning the "blow holes" away from the operator, a point which the user will appreciate. These holes are of ample area, and open direct to the atmosphere so there can be no accumulation of pressure above the piston. The drum is made of solid drawn tubing and the method of changing the tension of the drum spring is very simple. A shaft is provided with a pin with projecting ends. The upper end of the spring is attached to a knurled head, to which is connected a steel tube with a slotted end to engage the pin. These slots are slightly wedge-shaped, so that tension of the spring will hold the tube firmly in position without the aid of set screws or auxiliary springs. By raising the knurled head until the slots disengage the pin any tension may be given to the spring instantly. The style of the spring used is shown in Fig. 2. It admits of a perfectly even spring tension throughout the entire drum rotation.

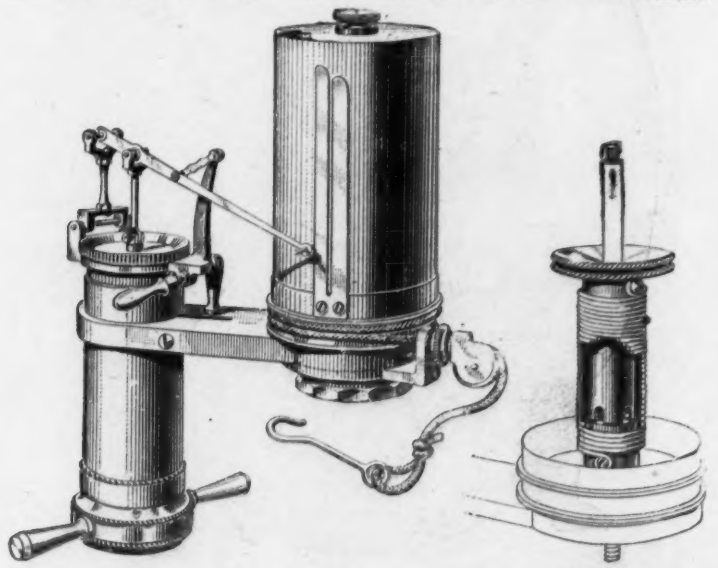


FIG. 1. FIG. 2.

This spring is not liable to break with use and may be quickly made by any engineer. The parallel motion is stated to be mathematically correct and gives a straight line. All the joints have wide bearings, and the entire movement is polished and blued.

The Vitae Carbon Brush.

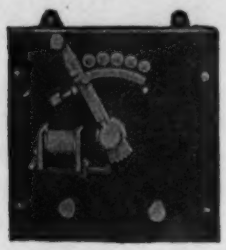
This brush is a treated carbon brush for motors, generators and dynamos, and is designed especially to save wear on the commutator. At the same time the brush, it is stated, wears much longer than any other. It is rapidly growing in favor, and although it is a little higher in price than any other carbon

brush, it is claimed that it is the cheapest in the end, on account of the great saving effected as regards wear on the commutator and the extraordinary length of life of the brush itself. The Le Valley Vitae Carbon Brush Company, 39 Cortlandt Street, New York, manufacturer of this brush, makes a specialty of car motor brushes for the street railway trade, and claims to have been very successful in this branch. One important street railway company using these brushes reports that vitae brushes have run nearly 19,000 miles on the motors of one of its street cars. These brushes have been carefully tested by hundreds of street railroads throughout the country, and have, it is stated, proved so satisfactory, and, in the long run so economical, that they have been very extensively adopted. The leading electrical companies are also using these brushes very largely.

Vitae carbon brushes have been on the market only a couple of years, but the business of the company has largely increased. The wide adoption of its brushes is explained on the ground of their inherent good qualities and properties. The manufacturer claims that the brush does not cut or wear the commutator in the slightest degree, and that it is self-lubricating, never gumming the segment tips. It requires no attention, and runs, it is claimed, from seven to ten degrees cooler than any other brush, at the same time possessing greater conductivity. This latter quality is an important one, in that it avoids any loss of current in the brush. Another important feature of the brush is that it leaves no deposits of dust on the motor, which is one of the causes of short circuit.

An Electrically Operated Air Propeller.

The air propeller illustrated herewith is manufactured by the Fuller Company, Detroit, Mich., and is driven by an electric motor of the most modern construction, manufactured by the same company. It is a multipolar, Paccinoti type, form-wound machine, the insulation resistance of the windings, both of the fields and armature, exceeding one megohm. The commutators are of hardened copper, thoroughly insulated with mica in all parts. Automatically fed carbon brushes are used on the machine, the bearings of which are of the self-oiling type, and so arranged that the apparatus may be placed in any position—on the floor, wall or ceiling.

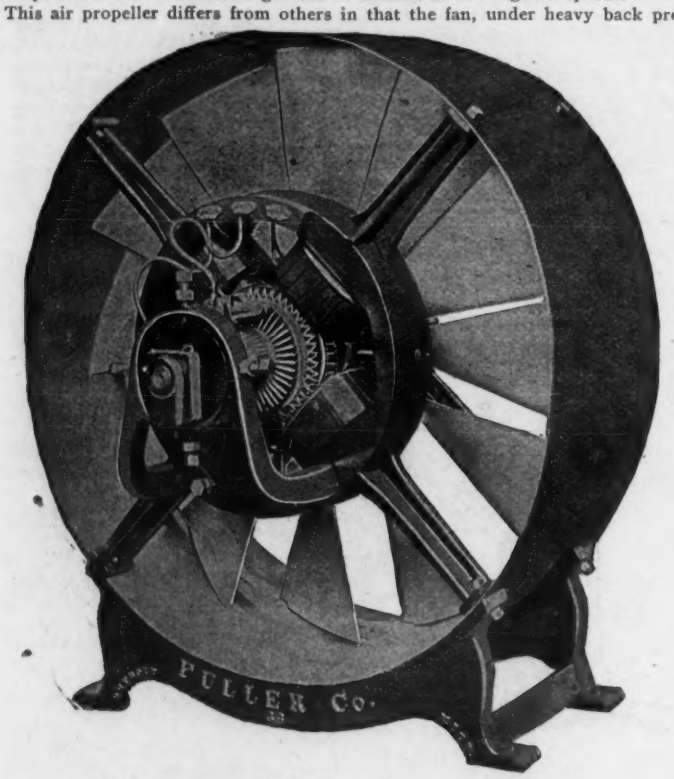


Starting Box.

The combined starting and regulating box provides five speeds. It is entirely fireproof, and so arranged that on the opening of the circuit it releases automatically at any of the speeds.

The propeller blades are made in special dies, giving a true helical, or screw pitch, from the disc outward. This method of manufacture insures uniformity in all blades. The helical pitch moves the air forward in a direct line, and is said to absolutely overcome all possibility of back-lash. Under actual working conditions there is no vibration, as the blades or floats are securely held in place by a retaining ring riveted to the periphery of the wheel, thus making it impossible for the wheel to get out of balance at the highest speeds.

This air propeller differs from others in that the fan, under heavy back pressure, actually takes in air at the top of the blade as well as along the surface, thus overcoming a great fault in many other air propellers under working conditions, namely, the slippage of air.



Air Propeller Driven by Electric Motor.

The entire apparatus, with motor attached, takes up no more room than the ordinary pulley-fan, and can be easily shifted around in applying it to windows, shafts or flues. Anemometer tests on installations using these propellers have been made, showing, it is said, that these machines handle from 35 to 40 per cent. more air per horse-power applied to the shaft than any other now on the market.

An Improved Gas Machine.

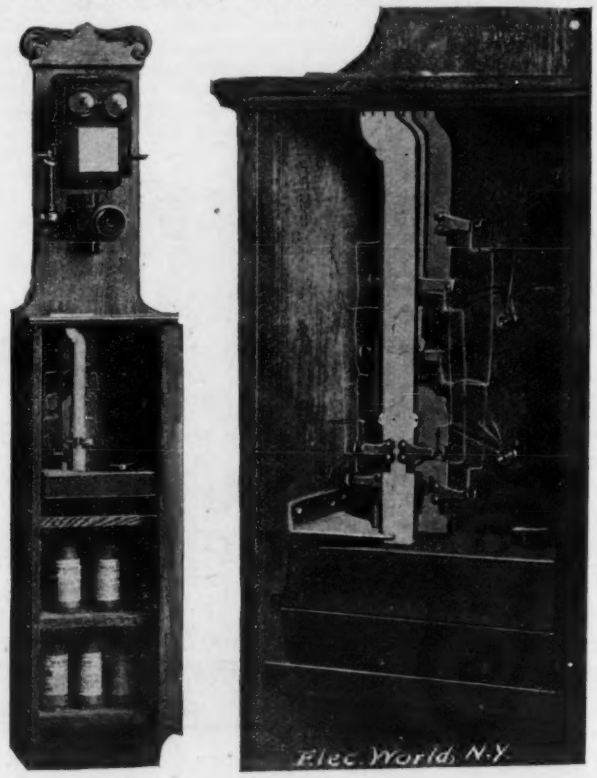
The economical production of gas for the operation of gas engines, for illumination and for fuel, is a question that is receiving much attention, and developments in this line are sure to attract wide attention. The Johnson gasoleum machine, manufactured by the Johnson Temperature Regulating Company, 240 Fourth Avenue, New York, is said to produce gas at a cost less than 75 cents per 1000 cubic feet. The gas is produced from gasolene, safely, economically and automatically, and the machine which accomplishes these desirable results is claimed to be as perfect as machines of this kind can be made. The automatic features of the machine are simple and effective, and wherever water pressure from the street service or house-tank is obtainable the machine requires no attention whatever. The gas may be used for house or street lighting, cooking, heating or power purposes. Gas engines for the driving of generators, and for other power purposes, can, it is stated, be operated at a cost not exceeding 1 cent per hp-hour. A large number of these machines are in use throughout the country, and they are said to be fulfilling all the claims made for them. The Sawyer Electrical Company, 1308 Arch Street, Philadelphia, is agent for Pennsylvania and Southern New Jersey, and is now in a position to install a gas-electrical plant complete—from the gas generator to the dynamo and lamps.

Automatic Telephone Pay Station.

A reliable prepayment telephone device for toll stations has long been a desideratum among independent telephone companies, and the apparatus manufactured by the Mason Telephone Pay Station Company, of Ludington, Mich., and described and illustrated herewith, is recommended as meeting every requirement of an instrument of this class. This machine is designed for use in such locations as hotels and other public places, and consists of one or more flat tubes, through which coins of various denominations pass before dropping into the cash vault. These tubes are arranged to keep the coins on edge during their travel, the coins passing between electrodes projecting into the tubes at intervals. As the coins strike these electrodes the circuit is momentarily closed and produces a distinct vibratory click, which is audible to the central operator, each denominational coin giving a certain number of signals during its passage through the tube. The operator is thus enabled to determine the denomination of the coin that has been inserted in the machine. No coin excepting the one intended for the tube will produce the proper signal, or, in fact, any signal at all.

In the five-slot machine there are tubes for dollars, half-dollars, quarter-dollars, dimes and nickels. The slots are cut to a size to just admit the coin that is intended for it; a nickel or a penny will not pass into the dime slot, and while a penny will go into the nickel slot, it will not touch the electrodes and will not produce any signals. The electrodes are adjusted by little thumbscrews to the exact size of the coin intended for the tube. The same method of adjustment is applied to all the tubes.

A separate battery, usually three dry cells, is used for the signaling circuit to which the electrodes of the various tubes are connected. This same circuit is included in the primary circuit of the transmitter induction coil, but does not pass through the magneto bell or the transmitter head.



Figs. 2 and 3.—Slot Mechanism.

In the accompanying illustrations, Fig. 1 shows a diagram of the connections, Fig. 2 a view of a telephone equipped with the slot apparatus, the front of the case being removed to show the position of the device with reference to the other parts of the instrument, and Fig. 3 is an enlarged view of the slot tubes with their connecting wires.

The coin apparatus does not in any way add resistance to the talking circuit and does not affect the operation of the telephone in any way whatever. The

circuits of the coin tubes are normally open. No extra wires are necessary, and the device may be attached to any reliable make of telephone instrument without any alteration to the latter. The simplicity of the device is a very strong point in its favor, since there is nothing about it to become easily deranged.

The Mason Company is putting out these instruments under a strong guarantee, and will ship a machine on thirty days' trial to any responsible telephone company. Several hundred of these instruments are now in daily use by some of the most prominent independent telephone companies in the country and, it is stated, are giving very satisfactory service. The Citizens' Telephone Company, of Grand Rapids, Mich., is using some of the instruments, and states that its operators have no difficulty whatever in distinguishing the denomination of the coins used in payment, and not a single complaint has been made of any failure of the apparatus.

In using the instrument the central operator is called in the usual manner, and the name and location of the person desired are given. As soon as the operator is ready the coins to make the necessary payment are dropped into the tubes, one at a time, the operator distinguishing from the number of clicks the denomination of each coin so used. The desired connection is then given, and the conversation proceeds in the usual manner.

It is stated that this device does not infringe in any way any other patents.

Factory of the Standard Thermometer & Electric Company.

The name of the Standard Thermometer & Electric Company, of Peabody, Mass., has become so well known in the electrical trades, through its arc lamps, that a short description of its factory and methods of manufacture may not be out of place at this time.

The company has occupied the building in which it is now located for the last fifteen years, the first six of which were devoted solely to the manufacture of thermometers; but during the last nine years the company has been making arc lamps besides. The building is 50 by 60 feet and four stories high, with a basement, the entire space being occupied by the works of the company, which take up, in addition, two stories of an annex, 20 by 40 feet.

In the basement of the main building are located the boiler and engine, the latter being a 60-hp Fitchburg. Besides these there are the blacksmith forge and the annealing and brazing forge. Partitioned off from the main space in the basement are four dynamos, one a 110-volt multipolar machine for shop-lighting and lamp-testing; another is an alternator rigged up with a speed-change counter, in order to test lamps of different frequencies; the third is a convertible 220-volt or 550-volt machine for testing direct-current lamps at these voltages, and the fourth is a series machine for either 6.8 amperes, 10 amperes, or any current between these limits, the latter machine being used for testing and adjusting the constant-current lamps. Elsewhere in the basement is a line of presses and a drop hammer, where the drawn and punched work is manufactured. A polishing and plating plant is also located in the basement, where the finishing of cases for the lamps and thermometers and the plating of the working parts and inside portions of the lamps are done. The plating current is supplied by a separate dynamo.

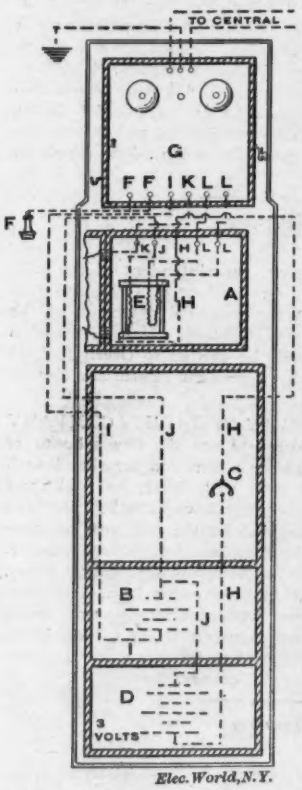
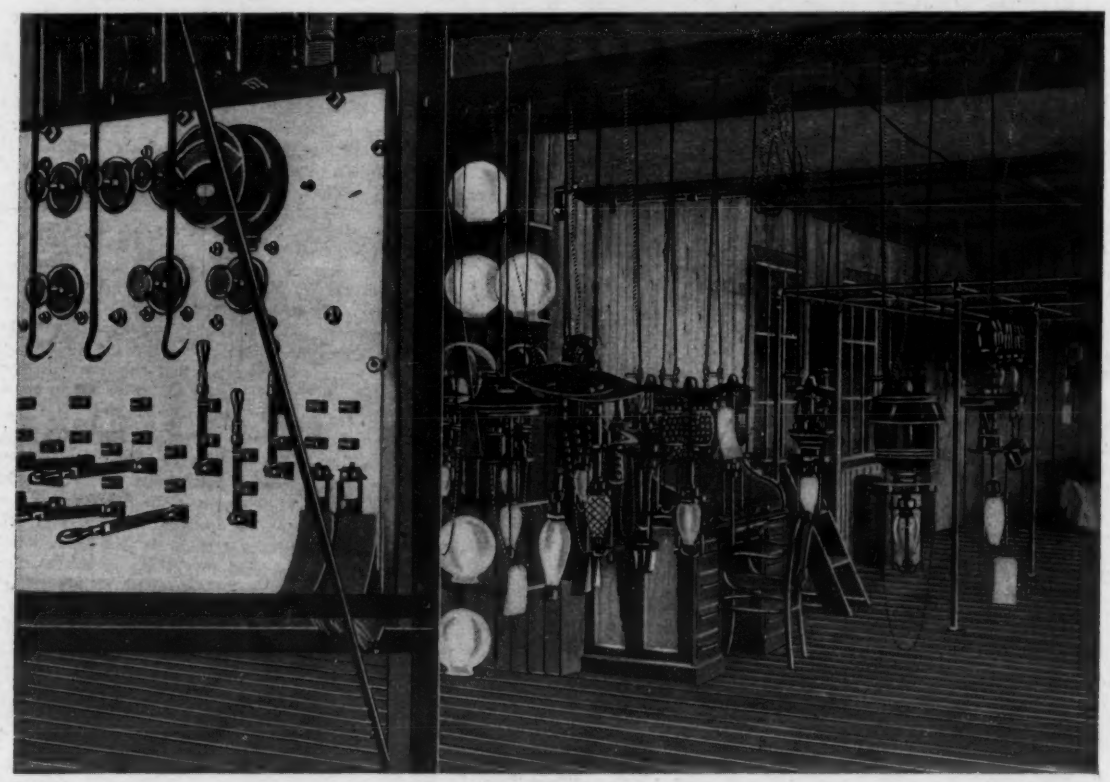


FIG. 1.—PAY STATION TELEPHONE CONNECTIONS.



A CORNER IN THE ARC-LAMP TESTING ROOM.

The office is on the ground floor, and takes up about one-quarter of the space, the rest of the space being occupied by the heavy machinery, such as lathes, drills, planers, etc. Here the heavy work on the arc lamps is done.

On the second floor the finer and lighter machines are placed, and here the small parts of the arc lamp are made. In the annex, on this floor, are the japanning ovens, heated by gas; also a small, special tool room and a room where telemeters are assembled and standardized.

On the third floor are the stock room, the shipping room and the arc-lamp testing room. The arc-lamp testing room, a view of one corner of which is given herewith, is one of the most interesting places in the entire shop. In this room there are three separate switchboards, one for alternating current and equipped with racks for testing open alternating-current lamps, and with instruments for controlling the alternating dynamo in the basement; the second board carries the controllers for the multipolar direct-current dynamo in the basement used for lighting the shop and for testing open or enclosed 110-volt lamps. For the testing of enclosed arc lamps there are ranges of drops into which the lamps can be connected and to which current can be run from either the alternating-current board or the direct-current board, as desired. The distribution of the direct and alternating currents is effected by means of the third switchboard, which is equipped with a complete set of throw-over switches, by which any of the lamps may be connected to the recording instruments or to the indicating voltmeters, ammeters or wattmeters, as desired. The exact current consumption can be readily determined and the necessary adjustments easily made.

The Standard Thermometer & Electric Company makes open and enclosed arc lamps for a variety of currents—direct 110 to 220 volt lamps, burning in multiple; 220 volts to 550 volts, burning in series, constant current of 4 to 7 amperes, and alternating current of frequencies from 7200 to 16,000 alternations.

In addition to the current generated on the premises, wires from the town plant are led into the testing room, and a great many of the lamps are run on these currents for continuous records and for testing. One current being of 16,000 alternations, and the other 6.8 amperes constant, the testing of lamps can be proceeded with at times when the rest of the factory is shut down. This, in rush hours, is a great convenience. The lamps are first tested without covers until they run at the required current consumption; they are then encased and run for several hours to develop any imperfections that may interfere with their proper operation after they leave the shop. The latest improvements in the construction of the lamps are the result of six years' experience in practical use. They meet all the weak points that have been shown to exist, which, as fast as discovered, have been studied and overcome. The constant trying of new devices for the improvement of the lamp is another feature of the testing-room work which requires the constant burning of a more or less number of new lamps.

The top or fourth floor of the main building is used for assembling the lamps and thermometers. The parts are sent to this room from the stock room as needed and put together rapidly and skillfully by the workmen there. The winding of magnets and solenoids is also done on this floor, the spools being driven by individual motors run by the 110-volt lighting current. This method of operation was adopted on account of the possibility of obtaining instantaneous speed control.

The long experience in the manufacture of arc lamps by the Standard Thermometer & Electric Company has brought with it much information regarding the art that is not always available in the general run of shops. It is stated that the success of the old "Ward" lamp was due in no small measure to the skill used in its construction by this company, which built all these lamps, and this applies as well to the Kinsman and Knight lamps. The original "Midget" lamp of this company, it is claimed, was the first introduction to the trade of the shorter arc lamps burning a 12-inch carbon, which result was accomplished by placing the clutch directly on the carbon and doing away with the use of a carbon rod.

Mr. Roger Upton, the president of the company, is a wide-awake and active official, and the same may be said of Mr. Samuel C. Lord, secretary and treasurer; Mr. J. H. Hallberg, electrician and designer of the company's arc lamps; Mr. M. L. Livingston, assistant manager, and who is constantly on the road; and Mr. Edgar Upton.

NEWS OF THE WEEK

Financial Intelligence.

THE MEXICAN TELEGRAPH COMPANY has declared a quarterly dividend of 2½ per cent., payable on January 13.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of New York, has declared a quarterly dividend of 1½ per cent., payable on February 1.

THE NEW LONDON STREET RAILWAY COMPANY, New London, Conn., has declared a semi-annual dividend of 2½ per cent. payable on January 2.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of New York, reports for the month of November, gross earnings, $286,941.21, an increase over the same month last year of $39,645.77; net earnings, $124,873.96; increase, $4,305.76. Gross earnings for the eleven months ended November, $2,711,602.62, an increase of $505,972.06; net earnings, $1,134,059.81, an increase of $156,237.73.

MORTGAGE ON THE OLD WALKER COMPANY'S PLANT.—A Cleveland dispatch states that on January 2 a second mortgage on the plant of the Walker Company, in that city, was filed with the County Clerk on that day. The amount of the mortgage is said to be $1,650,000. It is stated that the Westinghouse Electric & Manufacturing Company, which recently absorbed the Walker Company, intends to double the capacity of the old Walker plant.

THE AMERICAN BELL TELEPHONE COMPANY, according to a Boston financial paper, has sold $3,000,000 4 per cent. ten-year debenture bonds to two Boston financial houses, jointly. The price is understood to have been 102.32. These bonds are part of an issue of $10,000,000 debentures, of which $5,000,000 were issued in June, bearing date of July 1, 1898, running for ten years. The recent transaction leaves $2,000,000 to be issued. The company, it is stated, has not yet disposed of 1500 shares of stock, which it is at liberty to sell at auction.

Special Correspondence.

New York Notes.

SELECTING AUTOMOBILES FOR FIFTH AVENUE.—Dr. Louis Duncan, of Johns Hopkins University, Baltimore, was in town during the past week for the purpose of examining the various automobile systems that have been presented for the consideration of the Third Avenue Railroad Company in connection with the utilization of this class of vehicles on the Fifth Avenue stage line. The advantages of electricity, compressed air, petroleum and naphtha vehicles were set forth by the representatives of these various systems.

ELECTRIC ROAD IN OPERATION DOWNTOWN.—The Metropolitan Street Railway Company is now running electric cars downtown as far as Barclay Street on the Sixth and Eighth Avenue lines, on both of which the open-conduit electric system is now in full and regular operation. Regular service is now maintained from the Polo Grounds on the Eighth Avenue line, at One Hundred and Fifty-fifth Street, and on the Sixth Avenue line from One Hundred and Twenty-fifth Street south to Barclay Street, via West Broadway. The through service was inaugurated on last Monday night.

A MEETING OF THE NEW YORK ALUMNI of the Worcester Polytechnic Institute was held on Friday evening, December 16. An organization was formed with the following officers: President, T. Spencer Miller, '79; first vice-president, Dr. J. Brace Chittenden, '88; second vice-president, John M. Goodell, '88; secretary, Arthur L. Rice, '91; treasurer, Ralph Woodward, '85. Directors, W. S. Morehouse, '86; Frank B. Knight, '92; Harry B. Prindle, '85; Walter Hill, '80; Lucius B. Morgan, '73. There are a large number of Worcester Polytechnic men engaged in engineering work in the Greater New York, and the organizers of this branch alumni association intend that it shall be a strong and active one.

NEW ASSOCIATE MEMBERS OF THE INSTITUTE.—At the meeting of the American Institute of Electrical Engineers held on the afternoon of December 28 the following named gentlemen were elected associate members: John Allan, Sydney, N. S. W.; John Jacob Bellman, electrical engineer, Crocker-Wheeler Electric Company, New York; Robinson Crowell, General Electric Company, Schenectady, N. Y.; Henry B. Dates, professor of electrical engineering and physics, Clarkson School of Technology, Potsdam, N. Y.; John C. Finney, Milwaukee, Wis.; William N. Gladson, professor of electrical engineering, Arkansas Industrial University, Fayetteville, Ark.; Leo Walter Hildburgh, student, Columbia University, New York; William B. Hodge, electrical engineer, Elmer G. Willyoung & Co., Philadelphia; Saitaro Oi, chief engineer of the Bureau of Telegraphs, Tokyo, Japan; Francis E. Tyng, manager Eastern Engineering Company, New York, and Arthur J. Wood, associate editor "The Railroad Gazette," New York.

THE EAST RIVER TUNNEL.—President Baldwin, of the Long Island Railroad, has been interviewed on the subject of the East River Tunnel. He calls attention to the fact that the experience of recent years in foreign countries, as well as in some parts of the United States, demonstrates the economy and efficiency of tunnels as compared with bridges for handling passengers. One important factor to be considered in this connection is the enormous cost of land for bridge terminals as compared with no cost for the right of way for deep tunnels. He points out that any new bridge terminal in Manhattan would not reach the north and south movement of traffic. He expects that both tunnels and bridges will be built within the next ten years. A tunnel between Brooklyn and Manhattan, he states, would render it possible to travel from any station below the City Hall, in Manhattan, to Flatbush Avenue, in Brooklyn, in seven or eight minutes. At the latter point the passengers could secure cars for different points in the borough. It is probable, he thought, that separate fares would be collected in the tunnel, but the extra fare would certainly not be more than 2½ cents, which, he stated, was not very much, taking into consideration the saving of time.

Buffalo and Niagara Falls Notes.

TWO NEW 500-volt generators have been tested at the Wilkeson Street station of the Buffalo General Electric Company, and found to be entirely satisfactory. They will be operated by Niagara power, and are to be used for power purposes instead of lighting. There are now thirty machines in the station.

REFUNDING BONDS.—The Buffalo General Electric Company is refunding its old 6 per cent. bonds, which were due in 1900, into new 5s, thereby saving $21,000 a year in interest. The undertaking has been so successful that the stock of the company advanced ten points before the transaction was completed.

TO INCREASE THE ALUMINUM OUTPUT.—The Pittsburg Reduction Company is preparing to enlarge the works at Niagara and take 4000 additional electric horse-power as soon as it can. When that is done the monthly output of aluminum will be about 700,000 pounds. Large improvements will also be made to the company's works at New Kensington, Pa. The capital stock has been increased to $500,000.

A STORAGE-BATTERY PLANT FOR BUFFALO.—The Niagara Power Company is about to establish a big storage battery in the new Wilkeson Street power house of the Buffalo General Electric Company. It will be the property of the latter company, and will be used in its interest so far as needed. The battery will be of 2000-hp capacity, and will run 20,000 lights for over two hours. The battery is to be built by the Electric Storage Battery Company, of Philadelphia. With this battery available it is thought that any ordinary stoppage of the current from the Niagara power house can be bridged over.

Chicago Notes.

MR. DEWEY NEWMAN, formerly connected with the Central Electric Company, of this city, will in the future represent the Illinois Electric Company in the States of Illinois and Iowa. Mr. Newman entered upon his new duties on the first of the vear. He will be present at the meeting of the Northwestern Electric Association in Milwaukee on January 18, 19 and 20, and will be pleased to meet his many friends on that occasion.

THE "COOK" TELEPHONE PROTECTOR.—Early in 1897 Mr. Frank B. Cook, of the Sterling Electric Company, Chicago, brought an interference suit against a patent covering "Strong Current Protection," issued to Mr. Frank R. McBerty and assigned by him to the Western Electric Company. The case, The Electrical World is informed, was recently decided by the Patent Office in favor of Mr. Cook. The protector in question is the "Cook" device which has been extensively used by Bell telephone companies, and is now being manufactured by the Sterling Electric Company for independent telephone companies.

Wisconsin Notes.

RAILWAY EXTENSION.—Mr. E. E. Downs, superintendent of the Citizens' Traction Company, of Oshkosh, and C. O. Josslyn, of Oshkosh, were recently in Neenah looking over the route of the proposed extension of the electric interurban railway to connect Neenah and Oshkosh. If this extension is built it is expected that the line will eventually be carried to Green Bay, as Neenah and Appleton are already connected by a modern interurban electric railway recently put in operation.

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY recently made the city of Milwaukee a proposition to pay the city a bonus of over $2,000,000 in twenty-five years in exchange for a free run for that length of time. This proposition, however, did not meet with favor, but did meet with considerable opposition. Several special meetings have been held, but the matter is still unsettled. It will be remembered that for the past year or more the city has tried to get a 4-cent fare from the company, but failed to do so. The citizens have made matters interesting for the company at different times, and now the latter wants peace, but will not grant a 4-cent fare. The company claims that it is unbusinesslike under the present circumstances, being under great expense on account of the big improvements lately made, and at present being made. The company will pay $58,706.16 for taxes for the year 1898; $53,422.64 goes to the city and $5,283.55 to the county.

St. Louis Notes.

THE FRANK ADAM ELECTRIC COMPANY has filed articles of incorporation, with a capital stock of $25,000. The owners of the stock are Frank Adam, Fred B. Adam and Louisa M. Adam. The company will engage in the manufacture of electric appliances.

TRACTION SALE COMPLETED.—The deal between the Central Traction Street Railroad Company, of this city, and Brown Brothers, representatives of the New York Syndicate, has been closed and the traction company's interest will be sold to the New York parties. The price received was very satisfactory. Brown Brothers are to construct the lines after the plans made by the

first officers of the company. Being purchasers of the Missouri and Lindell railways, the syndicate will operate all three lines in conjunction.

THE MISSOURI INDEPENDENT TELEPHONE EXCHANGE ASSOCIATION.—Representatives of the Independent Telephone Exchange Association in Missouri perfected an organization here on December 27 by electing the following named gentlemen as officers: J. A. Hudson, of Columbia, president; W. N. Wicks, of Glasgow, vice-president; Theodore Gary, of Macon, secretary and treasurer. C. E. Betts, Geo. R. Armstrong and John Enoch will serve, together with the president and secretary, as an executive committee, in whose hands will rest most of the important work of the association. Forty-five of the leading exchanges in various towns are in the association. It is claimed in the by-laws adopted that the purposes of the organization are to improve the present facilities of rural exchanges, and try to secure long-distance and Metropolitan connections. It is hoped to connect the various exchanges by long-distance lines.

PACIFIC COAST NOTES.

ELECTRIC LIGHT BILLS VETOED.—Mayor Phelan, of San Francisco, has vetoed two additional authorizations for payment of demands for lighting the city on the ground that the contract awarded by the supervisors for lighting the streets is illegal.

MR. L. D. TANDY, of the General Electric Company, New York, returned to the East to spend the holidays. He is expected to return and to continue his work of planning for the electric transportation of passengers to and from the Southern Pacific ferry depots in Oakland, Cal.

THE SAN FRANCISCO BRANCH OF THE INSTITUTE.—The thirty local members of the American Institute of Electrical Engineers recently enjoyed a dinner in San Francisco. Professor Perrine read a paper detailing the results of some recent electric researches. It is proposed to hold a similar gathering every six weeks in future.

A 31-MILE TRANSMISSION PLANT.—The Snoqualmie Falls Power Company has almost completed its 31-mile electric transmission to Seattle, Wash. The pole line, which is now completed, will carry six aluminum wires arranged in two three-phase circuits. The generating units will be four in number, each composed of a 1500-kw, revolving-armature, direct-connected, three-phase generator. There will be twelve 500-kw step-up transformers. The initial voltage will be 1000, and the transmission frequency 7200 alternations. Contracts have been made to operate motors in Seattle in January. The Tacoma pole line will parallel the Seattle line on the same right of way for the first 19 miles. The entire distance from the falls to Tacoma will be covered by two three-phase circuits of wire, very slightly smaller than that running to Seattle. It is the intention to deliver 4000 kw at 25,000 volts, with a loss of 15 per cent. of the power delivered.

FORTY-MILE ELECTRIC POWER TRANSMISSION.—The Mount Whitney Power Company, of Visalia, Cal., has commenced work on its 40-mile electric power transmission. Water will be diverted from the Kaweah River, the power station being located about 29 miles east of Visalia, in an air line. The points to be reached are Visalia, Tulare, Porterville, Lindsay and Exeter. The pole line branches, the extreme end of one arm being located at Porterville. About 1350 kilowatts, or 1800 horse-power, will be transmitted at 17,300 volts to begin with. Later, as the load is increased, the voltage will be raised to 34,600. The power will be utilized chiefly for pumping purposes in connection with irrigation. Special tangential impulse-wheels have been designed for the hydraulic installation. There will be 6 miles of flume, and a short rock tunnel at the head works. The head of water available is 1325 feet. Robert McF. Doble is engineer of the company, with offices at 202 Sansome Street, San Francisco.

A MUNICIPAL ELECTRIC LIGHTING PLANT.—The Water Committee of Portland, Ore., recently took action looking toward the installation of an electric lighting plant by the city. The new city charter provides for the completion of an electric light and water system in 1905, if possible. It is estimated that 160 horse-power could be obtained by utilizing the natural flow of the city water from the high reservoirs to the lower ones. A report was presented advancing the opinion that the city should not pay more than $50,000 per year for the lighting service now given by the Portland General Electric Company at an annual expense of about $80,000. Seven hundred and three 2000-cp arc lights and 637 incandescents are now in use. Unless current can be contracted for at about $4 per horse-power the idea is to install a municipal electric system. The Construction Committee was instructed to at once obtain data and report upon the manner and cost of purchasing, installing and maintaining a lighting plant of sufficient capacity for the needs of Portland.

FRENCH NOTES.

ELECTRICITY IN THE NAVY—TORPEDO SERVICE.—The Secretary of the Navy has proposed the creation of a high commission which will bear the same relation to the torpedo service that the Commission de Gavre does to the ordnance service. The commission would be responsible to the directors of sub-marine defense. The Commission on Experimental Work, which has been in active service on board the "Algerisas," would cease to exist. The members of the new commission would be a captain of a frigate as presiding officer, a first lieutenant as secretary, a first-class mechanician, a captain of artillery, a sub-engineer of naval construction, and the professor of electricity of the Torpedo Service School. This body would replace also the Experimental Commission of the five ports.

FINANCIAL REPORT ON THE OPERATION OF THE PLACE CLICHY CENTRAL LIGHTING STATION.—A meeting of the stockholders was held October 27. The report for 1897-98 was read and approved and a dividend of $5 per share voted. For the year ending June 30, the gross receipts, which were $443,995.11 in the preceding year, rose to $537,191.96. The total expenses were $167,983.50, as against $134,586.62 in the preceding year. The resulting profit is $369,208.46, instead of $309,408.49. This figure should be increased by $16,000 premium received from the sale of shares, which brings the yearly gross profit up to $385,208.46. From this sum must be deducted for general expenses, $98,700.38, and for expenses of stock issue, $6,498.04; for depreciation of mains and feeders, $30,000. Totals, $135,198.42, leaving a net profit of $250,010.04. The dividend absorbs $60,000 of this profit, and the remainder, $190,010.04, is carried to the surplus and sinking funds accounts.

WIRELESS TELEGRAPHY.—M. Mascart read a communication to the Academy of Sciences on the latest experiment in wireless telegraphy carried on by M. Ducretet between the Eiffel Tower and the Pantheon, the Eiffel Tower being used as transmitter. The distance covered is 2½ miles. The signals which reached the Pantheon were always very distinct, even in a heavy fog, which shows that the distance can be increased. M. Ducretet's results are highly interesting in view of the fact that they were obtained in a city, and that the space between the two monuments is covered with high buildings. His receiver at the Pantheon is very delicate, and is arranged so that the message can be taken by ear. M. Ducretet has had a new very high mast erected at his laboratory in the Rue Claude-Bernard, and he expects to start a new series of tests between that point and places outside of Paris.

AN ELECTRO-MAGNETIC MERCURY CONTACT-BREAKER.—M. P. Villard exhibited before the Physical Society a mercury interrupter, which is operated by the action of a permanent magnet on the current. A copper rod mounted on a spring so that it can vibrate carries a nickel tip which makes contact with a mercury cup at the end of each vibration. This rod lies between the poles of a permanent magnet, which is so placed that every time the contact with the mercury cup occurs the rod receives an impulse away from the mercury cup. This impulse breaks the circuit and is sufficient to keep the rod vibrating. The rate of vibration may be reduced by weighing the rod. This interrupter, which is intended to be used with induction coils, works with perfect regularity under currents of widely different strengths, is of very simple construction, requires no auxiliary battery or shunt circuits, consumes a negligible amount of energy in its operation and has practically no self-induction.

SEARCHLIGHT IN COAST DEFENSE AT BREST.—Experiments were tried recently at Brest on the value of a combination of fixed and movable searchlights for harbor defense against torpedo boats. Five torpedo boats were sent out to the open sea in the afternoon to try and enter the harbor unperceived, after dark. At 9 o'clock the lights on Cornouaille Point discovered the first torpedo boat, which was moving parallel to the southern coast, and just about to try entrance to the harbor. Immediately thereafter all the beams of the outlook stations were directed onto this boat, and the others, which soon made their appearance, and none of them was able to get out of the field of observation, in spite of their efforts to do so. This seems to indicate that it is not possible for any kind of boat to pass over a zone protected by a fixed light with converging beams without being discovered and followed by the beams from the movable searchlights. Each observation post is equipped with a fixed projector and several movable ones called finders.

A STEREOSCOPE FOR RADIOGRAPHS.—M. Chaband exhibited before the Physical Society some of the results of his experiments with X-ray pictures taken with a tube furnished with an osmo-regulator and one of M. Villard's interrupters in connection with a small induction coil capable only of a 4½ spark with its Marcel Deprez rapid interrupter. With this apparently inadequate outfit, M. Chaband got some excellent photographs of various parts of the human anatomy with the following exposures: Head, 2 to 5 minutes; adult pelvis, 2 to 5 minutes; adult chest, 10 to 30 seconds; knee and thigh, 30 seconds; thick part of the foot, 10 seconds; arm, 10 to 15 seconds; hand, 5 to 10 seconds. M. Chaband thinks his results were possible only by the use of the osmo-regulator, by which the resistance of a tube can be brought to a given point and maintained steady as long a time as may be necessary. The rapidity with which two photographs can be taken makes it possible to apply the stereoscopic method to the thickest parts of the human body. M. Chaband exhibited before the society a piece of apparatus for taking stereoscopic pictures and another arrangement by which the negative plates may be viewed immediately after being developed.

TRANSMISSION OF POWER IN FRANCE.—A bill will be presented at the coming session of Parliament by the Government with a view to rendering the establishment of electric power transmission enterprises easier than is now the case. It is to be hoped that nothing will interfere with the passage of this bill, as it will give a much-needed fillip to French industries. France is rather behind other countries in these matters. Switzerland, with its small area of 54,000 square miles, has developed and distributed 80,000 horse-power. Marcel Deprez demonstrated in France a long time ago that it was possible to transmit electric energy 36 miles; and since then the improvements have been so great that 100 miles can be covered with a loss not exceeding 55 to 60 per cent. Waterfalls are not wanting in France; there are many and good ones. The coming act of legislation should define the public rights in the matter of utilization of waterfalls, building of conduits and dams on property controlled by the State, the departments or the counties, because the growing needs of French industries absolutely require the development of these natural reservoirs of power, and this has hitherto been much hindered by the existence of old laws which are out of keeping with the modern economic conditions.

ELECTRICITY AT MONT-DORE.—M. A. Larezzari read a communication at the last meeting of the Society of Civil Engineers of France on a water-power plant at Mont-Dore. The water is taken from Lake Guery, which is on the route between Clermont-Ferrand and Mont-Dore, about five miles from that watering-place. It drains a watershed of about 3.8 square miles, over which the average annual rainfall is 59 inches. The Euper, a brook into which it empties, carries off a fairly large amount of water. The dam has raised the level of the lake 16 feet, and added about 1-10th square mile to its area. The power-house is on the Dordogne, just opposite the junction of the latter with the Euper. The water is piped to the power-house in sheet steel pipes, 2 feet in diameter, 9.157 inch thick, and 2800 feet long, giving a total fall of 131 feet. The available power is about 250 horse-power. The conduit follows the left bank of the Dordogne, then the slope of the railroad for 787 feet, and crosses the Dordogne, on a wooden trestle, spanning 52 feet, and 13 feet above the water. At the power-house the water divides into three streams and passes through three turbines direct connected to three generators. The current is generated at 550 volts and transmitted to Mont-Dore over two cir-

cuits, a distance of 11,000 feet. At Mont-Dore it is converted and distributed at a pressure of 115 volts.

THE BASTILLE-CHARENTON LINE IN PARIS.—This new line, just finished, between the Bastille and Charenton, and soon to be opened, was begun in February, 1898, and pushed to completion as rapidly as the congested traffic on certain portions of it would allow. The trolley is used mostly, it being permitted by the authorities largely as an experiment, to determine the possibilities from an æsthetic point of view; nevertheless, two portions of the line were required to be equipped with underground conduits, one of these being at the Place Daumesnil, and the other in the Rue de Lyons and the Place de la Bastille. The public street lighting is also done from the company's central station. The site selected for this station was outside the city, not far from St. Mandé fortifications. This is the first instance of the use in Paris of the system of light cars, with very frequent services, and should yield some interesting comparisons with the old system of heavy trains, with infrequent service, as regards the needs and preferences of the traveling public. The French Thomson-Houston Company did all the work connected with this line, even to the furnishing of the rolling stock. The results of this company's efforts go to show that for a great many of the streets and avenues of Paris and other large cities the trolley system of construction is not at all objectionable, and is quite as capable of being arranged so as not to be unpleasant, and even so as to be decorative, as any other necessity in street construction.

POSTING BY ELECTRICITY.—The old posting days, when hostelries and inns and highwaymen flourished, are to be revived if we are to believe the rumors that are on foot; but instead of horses, electricity and automobiles are to be the means of transport. M. Poelaert, of Brussels, has just received the draught of a project to be called the International Electric Post System, which contemplates erecting electrical central stations on roads suitable for driving, where accumulators may be recharged. The company, which is still in the formative process, will have a capital of one and one-half million dollars, and its central offices will be in Brussels. The generating stations will be from 10 to 12 miles apart, and all built alike. They will be fitted up to take care of other forms of traction vehicles, and bicycles, as well as electrical carriages, and will have a bar, a restaurant, a medical attendant, a repair shop and a stock of gasoline and parts of machinery. The first systems will cover the great carriage roads of Belgium and France; it is expected that the very first line, which should be in operation before long, will be on the road from Brussels to Paris along the Meuse Valley. The completion of these arrangements will bring about a revolution in automobilism, and the company will be the first to benefit by the new movement when it comes, but in the meanwhile it will at once attract considerable business from the horde of cyclists that fill the roads. There would seem to be too many people who will be benefited by the success of this project for it to fail.

AUTOMOBILE RACES.—M. Paul Meyan was the organizer of a hill-climbing contest for automobiles, which was run off November 27, with forty-five starters. The course was 5900 feet in length, and was laid out on the Chauleloup hill. The total rise from start to finish was 376 feet, and the average grade was a rise of 63.7 feet per 100, and maximum grade about double the average. The winner was M. Jenatzy, who covered the course in 3 minutes and 52 seconds in an electric carriage. The Count de Chasseloup-Laubat, with his electrical carriage, would probably have equalled this time, except for an accident. The second vehicle to cross the tape was a little petroleum cart owned by M. Jamin, time 4 minutes, 2 1-5 seconds. The third was a petroleum tricycle, M. Marcellin, time 4 minutes, 5 seconds. The first petroleum carriage, properly speaking, came in seventh, and was driven by M. Giraud (made by Amédée Bollée), time 4 minutes, 36 2-5 seconds. These results are somewhat misleading, as all the vehicles were especially arranged with this hill-climbing contest in view. Anyone who is familiar with the enormous elasticity of discharging power possessed by an accumulator, and the enormous overload which a motor will carry for a few minutes, will easily understand why electricity made such a brilliant showing in this contest. Experience has shown how easy it is to build such a vehicle for any given set of conditions, but it does not do to generalize with results so obtained. This does not in any way detract from the success of the competition organized by M. Meyan, the genial editor of "La France Automobile."

GERMAIN'S TELEPHONE.—There is a great deal of talk going on in Paris at present about the Germain telephone. The daily papers are full of detailed descriptions of the invention and its possibilities, but no one seems to have seen it except the officials of the Government Postal and Telegraphic Service. The following are some of the claims made for it: With the aid of what the inventor calls a rotary telephone it is possible to converse distinctly at a distance of 300 feet from the receiver; a message could be sent over a metropolitan system to ten thousand persons at a time. M. Germain reduces speech to the simplest possible vibratory expression, which he proposes to transmit over the longest possible circuits, whether of silicon, bronze, iron or steel, or whether on subterranean or sub-marine cables. The head officials of the telegraph bureau, after satisfactory experiments, have ordered a set of instruments to be made at the shops on the Boulevard Brune. To fill certain needs of the temporary organization of the telephone service, M. Germain has got out a telephonic relay. This instrument passes on the vibrations produced by sound just as a telegraphic relay does with ordinary signals. This relay is built on the same principle as the reducer to which we have alluded above. By putting this machine in circuit at telephone exchanges, or at the ends, or even in the middle of circuits, it is possible to go on using existing apparatus and yet obtain intensely strong articulations. This relay is also expected to prove of great value on underground and sub-marine lines by minimizing the effects of resistance and capacity. Finally, the Germain apparatus contemplates the possibility of recording speech at a distance, also to gather all the sounds in a room and mechanically record them.

General News.

New Incorporations.

THE SOUTH AMERICAN GENERAL ELECTRICAL SUPPLY COMPANY, of Schenectady, N. Y., has been incorporated with a capital stock of $50,000 to deal in electrical apparatus and mechanical devices in South America.

THE ELECTRIC INDICATOR COMPANY, Louisville, Ky., has filed articles of incorporation, with a capital stock of $30,000. Mr. Benjamin T. Verderisk, inventor of the new electric indicator for railroad passenger cars, is the chief stockholder.

THE CUBAN ELECTRIC COMPANY, Asbury Park, N. J., has been incorporated, with a capital stock of $1,000,000. The incorporators are William R. S. Melvin, East Orange, N. J.; G. K. B. Wade, New York; Herbert A. Howell, Henry K. Davis, New York, and Francis A. Fuller, Brooklyn.

THE ELECTRIC POWER DEVELOPMENT COMPANY, Camden, N. J., has been incorporated for the purpose of manufacturing and supplying electricity to municipalities. The incorporators are Marcus B. Taylor, Charles W. Kennedy, Isaac Blum, William Findlay Brown and S. Y. Heebner. Capital stock, $500,000.

THE SAN JUAN & RIO PIEDRAS RAILROAD COMPANY has been incorporated at Albany, N. Y., for the purpose of constructing and operating an electric or steam railroad, 7½ miles long, from San Juan to Rio Piedras, Porto Rico. The directors are George H. Walbridge, Fernando G. Echeverria, H. H. Harrison, Edward Schmidt, Lathrop R. Bacon, F. Kingsbury Curtis, Philip H. McMillan, Augustin N. Hand and William B. Parsons, New York city. Capital stock, $300,000.

The Telegraph and Telephone.

CINCINNATI, OHIO.—The Tristate Telephone & Telegraph Company is seeking a franchise in Cincinnati. Philadelphia capitalists are said to be behind the venture. The ordinance provides for subways and poles to string wires. The ordinance was referred to the committee on telephones and telegraphs.

NEW YORK, N. Y.—Colonel Kimball, of the Quartermaster's Department, in this city, has received orders from the War Department to secure at once an iron ship of from 1000 to 1200 tons for use in laying cables to interconnect the Philippine Islands. The department, it is stated, has ordered for the purpose 166 miles of submarine cable, weighing 525 tons.

TUSCOLA, ILL.—It is reported that the Bell Telephone Company has absorbed the Interstate Telephone Company, which had its headquarters in this city. The Interstate company owned and operated several hundred miles of lines in Central Illinois, and as the Bell company threatened to cover the same territory, a compromise was effected whereby the Interstate Company goes out of existence.

WASHINGTON, D. C.—The Grand Jury has found a true bill against Mr. Samuel M. Bryan, president of the Chesapeake & Potomac Telephone Company, on the charge of violating the act fixing the yearly rental of telephones in the District of Columbia. The company contended that the law which was enacted last June, fixing the yearly charges at from $50 to $25, was unconstitutional, and adhered to its former rates. The matter was taken up by a Citizens' Association, and many injunctions were obtained to prevent the removal of telephones upon tender by subscribers of the amount fixed by the act. These injunctions will be heard before the District Court on the constitutionality of the law in question.

WASHINGTON, D. C.—The contract entered into between the Hawaiian Government and the Pacific Cable Company, of New York, subject to the approval of the United States, has been disapproved. Secretary of State Hay issued a proclamation to this effect on December 31, his action in the premises being in accordance with the terms of the contract, which provides that it shall not take effect if disapproved by the State Department within six months from July 2, 1898. The contract gave the Pacific Cable Company exclusive cable rights between Hawaii and the United States and Japan, and the determination of this Government not to grant such exclusive privileges was the cause for revocation.

Electric Light and Power.

JAMAICA, L. I.—The Queens Borough Electric Light & Power Company will erect a new plant at Far Rockaway at a cost of $30,000.

COUNCIL BLUFFS, IA.—The plant of the Council Bluffs Gas & Electric Light Company was sold December 16 to pay a mortgage of $250,000 held against it.

THE HOTEL HAMILTON, Island of Bermuda, has just placed in operation a direct-connected lighting plant, consisting of a Westinghouse generator direct-connected to an engine built by the Ball Engine Company, Erie Pa.

NEW YORK, N. Y.—The Kings County Electric Light Company, of Brooklyn Borough, it is reported, has given an order to the Westinghouse Electric & Manufacturing Company for two 3000-kw generators. It is stated that these machines will cost between $80,000 and $85,000.

BANGOR, ME.—The Milo Electric Light & Power Company has been organized at Dover, with $10,000 capital stock, for the purpose of heating and lighting the towns of Milo, Sebec and Brownville. The officers are: President and treasurer, Julian d'Este, of Salem, Mass.

THIBODEAUX, LA.—Mr. G. U. Borde, 401 L. L. & G. Building, New Orleans, La., has been retained as consulting engineer of the City Council of this place to draw up plans and specifications for a complete electric light plant. Sealed bids on machinery and construction will be called for as soon as the plans are ready.

ST. HELENA, MONT.—At the last meeting of the Board of Town Trustees of St. Helena an ordinance was passed granting a franchise to the St. Helena Light & Power Company to erect a plant in this place. Work will commence about January 1, and it is expected the plant will be in running order in about ninety days from that time.

TONAWANDA, N. Y.—At a special meeting of the Board of Trustees of this village, held on December 28, a franchise was granted to the Niagara Falls Power Company to erect poles and string wires through the streets for the purpose of transmitting electrical power. By the terms of the franchise the town of Tonawanda will secure prices for its manufacturing concerns 10 per

cent. lower than those asked in the city of Buffalo and 2½ per cent. lower than the prices in North Tonawanda.

PHILADELPHIA, PA.—A corporation with a capital of $25,000,000 is in process of organization, and will shortly apply for a charter under the laws of New Jersey, which has for its object the combination of the electric light companies in Camden, Atlantic City and other points in New Jersey, and also places in Delaware, Montgomery and Chester counties. Philadelphia capitalists will be largely interested in the company, and negotiations are now being made with companies in the places where it is proposed to do business, with the view to securing the lighting privileges. There will be 500,000 shares of the new company's stock, par value $50. It is denied that 100,000 of these shares will go as a bonus to the stockholders of the Pennsylvania Manufacturing, Light & Power Company.

ATLANTA, GA.—The statement in THE ELECTRICAL WORLD of December 24 regarding the isolated plant installed in the Custom House in this city has brought out an explanation from Mr. H. M. Atkinson, president and general manager of the Georgia Electric Light Company. That gentleman states that the facts given in the previous article are erroneous. He states that the company has been lighting the United States Government Building for years, and that no complaint has been made either as to the character of the service or the cost of the lights. The contract, Mr. Atkinson states, was let for an isolated plant without the company having any notice whatever. The statement that the cost of the light furnished by that company was from $400 to $600 a month, Mr. Atkinson states, is an exaggeration. The average monthly bill paid by the Government for lighting the post office for eleven months of 1898 was $264.20. When it learned of the new contract the company offered to light the building at a figure less than the Government itself could furnish the light.

THE ELECTRIC RAILWAY.

LOS ANGELES, CAL.—The electric railroad known as the Los Angeles & Pasadena Railroad, operating between Los Angeles and Altadena, has passed into the possession of the Southern Pacific Company, the purchase price being $1,000,000.

GREENWICH, N. Y.—The company which is to construct the electric railroad from Schuylerville to Greenwich has purchased from the National Bank of Greenwich the extensive water power at Middle Falls, on the Battenkill. The price paid is understood to have been $10,000.

BROOKLYN, N. Y.—Thirteen thousand shares of Brooklyn City Railroad stock were sold at auction on December 28. Eight thousand shares sold at 242¼ and the remaining 5000 shares at 242½. The stock belonged to the C. N. Hoagland estate. The securities were purchased by a representative of the Mutual Life Insurance Company.

WASHINGTON, D. C.—Application has been made to the District Commissioners by A. E. Randle, president of the Capital Railway Company, for a permit to open the streets for the purpose of installing the Brown underground system northward on Eleventh Street to Lincoln Park. This proposed addition to the Capital Railway will give a connection with the Metropolitan line at Lincoln Park.

NEW HAVEN, CONN.—It is rumored that the New York, New Haven & Hartford Railroad will immediately make the largest change yet put into execution from steam to electricity by extending the third rail up the Naugatuck Valley, connecting Derby and Bridgeport, this city, Waterbury and a dozen small towns, and bringing together a population of a quarter of a million by this means.

HAVANA, CUBA.—It is stated that Percival Farquhar, on behalf of an American syndicate, which has been competing with the American West Indies Syndicate and a British syndicate for a railway franchise in Havana and the suburbs, has bought the Ferro-carril Urbano for $1,400,000. The papers completing the transfer were signed on December 29. Harry Payne Whitney is a member of the Farquhar syndicate.

RAILWAY EXTENSIONS IN BERLIN, GERMANY.—The German representatives of the Walker Company, Felix Singer & Co., of Berlin, have received an order from the Oberschlesisichen Dampfstrassenbahn Gesellschaft for the electrical equipment of twenty four-motor cars for the further extension of the lines of this system. These are narrow-gauge equipments, the rails being about three feet apart. This makes about 208 motors the company has ordered from the same house.

DAYTON, OHIO.—The Dayton, Springfield & Urbana Electric Railway Company has certified to the Secretary of State its intention to increase its stock from $10,000 to $75,000. The company is now branching out and will start at once on the line connecting the three cities. It is said to be the intention of those comprising the company to unite with the Dayton Traction Company and run a line through from Springfield to Cincinnati by way of Hamilton and Middletown.

ATLANTIC HIGHLANDS, N. J.—Chancellor McGill has decided that the receiver of the Atlantic Highlands, Red Bank & Long Branch Electric Railroad Company must recognize the claims of Eatontown township for $10,000, and of the Commissioners of Long Branch for $3500, and issue receiver's certificates for the amounts. The railroad company obtained its grant from the township on agreeing to pay one-half the cost of improving the highways and the franchise from Long Branch under a contract to pave a street. The railroad company began operating in 1895. The municipalities sued for damages for violation of the terms of the franchise.

JERSEY CITY, N. J.—The North Hudson County Railway Company, which, starting from the Hokoben ferries, controlled the surface roads tapping all the northern part of Hudson County, has passed under control of the North Jersey Street Railway Company, and the chain of electric railroads through the northern part of New Jersey is now practically complete. The North Jersey Company has now absorbed almost every one of the important existing lines in Hudson, Essex, Passaic and Union counties. It is said that the North Jersey Company paid the three controlling owners something in excess of 160 on stock purchased at about par, and by some it is said the figure is nearly, if not quite, 170.

HACKENSACK, N. J.—Senator William Johnson, receiver of the Union Traction Company, has been ordered by the Court of Chancery to sell the roadbed, cars, fixtures, buildings and everything else belonging to that company in Hudson and Bergen counties. The railroad is in operation from North Arlington to Woodridge, a distance of 8 miles. The company has secured a right of way as far north as Hackensack, but owing to the demand of this town for $50,000 for right of way, which the company could not pay, it went into a receiver's hands. It was admitted that if the right of way had been obtained here the company would have been able to float a million dollars' worth of bonds and complete its lines. The Metropolitan Trust Company is the complainant in the foreclosure suit. It is understood that at least four competitors will bid at the sale on January 27.

LAWRENCE, MASS.—Judge Knowlton, of the Supreme Court, has dismissed a bill brought by J. H. Foren and others against the Lowell, Lawrence & Haverhill Street Railway Company for a writ of mandamus to compel the respondent to reinstate certain men who had been discharged because they had refused to sign a specific bond. It appeared from the statements of counsel that some seventy-five or eighty men who were in the employ of the company as motormen and conductors were asked to sign a bond of the Fidelity & Deposit Company of Maryland, and that their refusal to do so had led to their discharge. The deposit company had proposed to the managers of the road that it would insure the road against accidents to property, and that it would take in payment an individual bond from each man. Each man was then told to sign the application and bond or be discharged. For this bond the men were required to pay $3.25, and the deposit company could raise or lower the bond at will, and could withdraw entirely upon giving a notice in writing. The men refused to sign and were discharged. A petition for a writ of mandamus was then brought, with the above result. The court said that while a public wrong may have been committed, no legal right has been infringed for which an action can be maintained. Counsel for the men contended that the principle involved is the same as that involved in an English case in which it was held that the men had a legal right to be reinstated.

PERSONAL NOTES.

MR. E. W. IRWIN, New York manager of the Pratt & Whitney Company, has resigned his position, and will engage in business on his own account.

MR. CHARLES J. KINTNER, patent attorney, 45 Broadway, New York, who has been ill for the past six weeks, is again back at his desk at work.

LIEUT.-COMMANDER S. DANA GREENE has been detailed for duty as aide to Col. Theodore Roosevelt, Governor of New York. Lieutenant Greene served on board the auxiliary cruiser "Yankee" during the Spanish-American war. He is a descendant of famous naval and army men, his father being first lieutenant of the "Monitor" when she fought the Confederate gunboat "Merrimac" during the civil war. His grandfather is said to be the oldest living graduate of West Point.

MR. W. J. CLARK, of the General Electric Company, has accepted the position of general manager of the foreign department, with headquarters in New York. This department will have charge of all commercial relations between the General Electric Company and all countries outside the United States. Mr. Clark's wide experience in foreign commercial matters peculiarly fits him for his new position. His book, "Commercial Cuba," recently published, is already generally acknowledged to be the standard authority on Cuban commercial affairs. Mr. D. Mazenet, who for five years held the general managership of the foreign department, becomes managing director of the Mexican General Electric Company, with headquarters in the city of Mexico.

LEGAL NOTES.

POLES OF AN ELECTRIC RAILWAY, if properly placed, are held, in Snyder vs. Ft. Madison Railway Company, Iowa Supreme Court, to give no right of action to the abutting owner, whether he owns the fee of the street or not.

LIMITING STREET-CAR FARES.—A statute limiting the fare to be charged by a street railway company is sustained in the case of Indianapolis vs. Navin, Indiana Supreme Court, provided the rates are not so low as to amount to a confiscation of property, or a taking of it without compensation or due process of law.

ORDERED TO FINISH AND EQUIP THE ROAD.—The case of Down against the Madison, Ind., Electric Railway Company the United States District Court authorized the receiver of the road to issue certificates and sell them for cash at not less than 90 cents on the dollar, to raise funds to complete and equip the road.

NEGLECT OF DUTY A BAR TO THE RIGHT OF ACTION.—A lineman, injured by contact with a span wire charged by a trolley wire which had a broken insulator, is denied a right of action in the case of Anderson vs. Inland Telephone and Telegraph Company, Washington Supreme Court, where he failed to test the insulator, although that was his duty.

CURRENT EXPENSES PREFERRED TO MORTGAGE LIEN.—Judge Brownlee, of the Howard County Superior Court, in the electric light receivership case at Kokomo recently, held that necessary current expenses incurred before the appointment of a receiver are preferred to the mortgage lien existing in favor of the bondholders. The decision is based on the idea that an electric light company is a quasi public corporation, and the discharge of its duties is of public interest, and if current expenses are not provided for it would be to the detriment of the public.

STREET RAILWAY FRANCHISE LITIGATION IN INDIANAPOLIS.—In the case of the City Railway Company vs. the Citizens' Street Railway Company, of Indianapolis, the Indiana Supreme Court, on December

16, held (1) that the Citizens' Street Railway Company's franchise in the streets of Indianapolis will expire in 1901; (2) the consent of the Common Council of a city is a necessary condition, precedent to the exercise of its franchise in the streets of such city by a street railway company, organized under the statute of 1881; (3) one street railway company cannot have a monopoly of the streets of a city, but its rights are exclusive only in such parts of the streets it actually occupies, as are required to lay its rails and operate its cars; (4) Section 59 of the Indianapolis city charter gives the city the right to make a valid contract with a new street railway company for the use by it for a term of years of any of its streets not already legally occupied for street railroad purposes in return for payment to be made and acts to be done by such company; (5) the contract between the City Railway Company and the city of Indianapolis is valid and binding; (6) the Legislature has the power to modify any franchise acquired under such a contract by a street railway company organized under the act of 1861. (Note.—The effect of the above decision will be to put the City Street Railway Company in immediate possession of certain streets now not occupied by the Citizens' Street Railway Company, and to give the former corporation a right to lay tracks in all the steets now occupied by the Citizens' Company on the termination of the latter's franchise in 1901. The Citizens' Company was organized under an ordinance passed in 1864. By its terms the franchise would have expired in 1894. In 1880 an ordinance was passed extending the franchise for seven years. This ordinance has been upheld by the Supreme Court of the United States. When the occupying corporation accepted that ordinance it accepted it as an entirety—time limit and all. The history of Indianapolis street railway litigation is interesting. The Legislature of 1897 passed a bill terminating all existing street-car franchises in Indianapolis in 1901. But the court holds that the Legislature had no power to abrogate a valid contract made with the City Company, and in fact did not do so. It is certain that a city can grant a new franchise during the life of an existing franchise. In this case the city granted a new franchise to a company to take effect eight years in the future. and the court holds it to be a reasonable exercise of power. The hope of a final settlement of the Indianapolis street car question is deferred by this decision, as the cause will be appealed to the Supreme Court of the United States.)

Educational Notes.

STUDYING AT HOME.—A profitable way to spend spare time is to study, and it is here where the system of instruction by correspondence of the United Correspondence Schools, 156 Fifth Avenue, New York, meets with success. These schools have been established for a sufficient length of time to have gained a reputation for the thoroughness of their courses. These courses, it is stated, have been improved from time to time, and now represent the result of seven years of experience in teaching by correspondence. Special electrical courses are offered in station engineering, electric lighting, electric railways, telephony, telegraphy and electroplating. A copy of Circular F, which contains a list of the courses and other information, will be sent on application.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., offers special advantages to secure an education, which, it is stated, enables students to pass government examinations. The object of the school is to give the busy man a thorough training in steam, electrical and mechanical engineering by mail. The electrical engineering course, which is said to be carefully supervised by electrical experts, is in close touch with the developments in the science. The instruction is carefully graded, thoroughly practical and scientific, and is intended to give electrical students and engineers a complete technical training. The school is chartered by the Commonwealth of Massachusetts, and is an educational institution, and not a money-making enterprise; therefore, the tuition fee is placed within the reach of all wage-earners. Those interested may obtain a copy of a handbook giving information on the subject by addressing the school.

Directory of Scientific Societies, Associations, Etc., and Meetings of the Same.

THE NEW YORK ELECTRICAL SOCIETY.—President, Gano S. Dunn; secretary, George H. Guy, 120 Liberty Street, New York.

HENRY ELECTRICAL SOCIETY meets every other Friday evening between October and May. Headquarters, 115 West Twenty-eighth Street, New York City.

AMERICAN STREET RAILWAY ASSOCIATION.—President, C. E. Sergeant, Boston, Mass.; secretary, T. C. Penington, 2020 State Street, Chicago, Ill. Next meeting, Chicago, 1899.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—President, A. M. Young, Waterbury, Conn.; secretary, George F. Porter, 203 Broadway, New York. Next meeting, New York, May, 1899.

NORTHWESTERN ELECTRICAL ASSOCIATION.—President, F. A. Copeland, La Crosse, Wis.; secretary, Thomas R. Mercein, Milwaukee, Wis. Next meeting, Milwaukee, Wis., January 18, 19 and 20.

CHICAGO ELECTRICAL ASSOCIATION.—Meetings, first and third Friday of each month, from October 1 to June 1; J. R. Cravath, secretary, Monadnock Block, Chicago, Ill. Future meetings and papers for the season of 1898-99: January 6, 1899, "Telephone Engineering—Some Problems Solved and Unsolved," by S. G. McMeen; January 20, "Observations on Ventilating Fans," Gerard Swope.

FRANKLIN INSTITUTE (Electrical Section), Philadelphia, Pa.—Secretary, Wm. H. Wahl. Programme of lectures for the season 1898-99: January 24, 1899, "The Practical Application of the Electric Motor to Printing Press Machinery," by W. H. Tapley; February 14, "The Electric Inspection of Street Car Equipments," by Mr. A. B. Herrick; February 28, "Some of the Larger Transportation Problems in Cities," by E. E. Higgins; March 28, "Water Power Electric Plants in the United States," by Mr. B. C. Washington, Jr.; April 25, "Design of Electromagnetic Mechanism, with Especial Reference to High Frequency Telegraphic Receivers," by Prof. Reginald A. Fessenden; May 23, "Electrical Clocks, Historically Considered; with a description of the Most Successful Applications of Electricity to Clocks and the Uniform Distribution of Time," by Mr. James Hamblett. On February 10 Mr. T. Commerford Martin will deliver a lecture under the joint patronage of the institute and the Central Branch of the Y. M. C. A. on the subject of "Electric Power Transmission."

Calendars for 1899.

CALENDAR-MAKING has developed into an art in recent years, and the examples of 1899 calendars so far received by The Electrical World show a decided advance over the efforts of previous years. There is a notable tendency in some cases to break away from the more conventional designs and substitute therefor individual ideas, and some of the results are certainly commendable.

THE OKONITE COMPANY, LIMITED, 253 Broadway, New York, presents on its 1899 calendar a very beautifully colored figure of a young girl. The picture is pretty enough to frame.

MESSRS. GEORGE I. ROBERTS & BROS., Incorporated, 471-473 Fourth Avenue, New York, show patriotism in their calendar for 1899. A colored picture represents the United States battleship "Oregon" pursuing the Spanish ship "Colon." The scene is a very animated one.

THE CONNECTICUT TELEPHONE & ELECTRIC COMPANY, Meriden, Conn., manufacturer of switchboards, telephones and telephone equipment, has issued a neat little calendar, which bears a very pretty colored medallion of the head of a Florentine girl. The coloring is very effective.

THE RASTER CARBON RHEOSTAT COMPANY, 231 South Canal Street, Chicago, is issuing a calendar of special and artistic design. The application of the Raster carbon rheostats is well exemplified in the design, and their meritorious features are pointed out. The mosaic design of the calendar is very effective.

THE H. T. PAISTE COMPANY, Philadelphia, is issuing to the electrical trade a very artistic calendar for 1899. The subject of the illustration is Grust's painting entitled "Good Night," and the reproduction is very effective. A copy of this calendar will be sent to any address on receipt of 4 cents in stamps to cover the expense of mailing.

THE LAIDLAW-DUNN-GORDON COMPANY, Cincinnati, Ohio, manufacturer of pumping machinery, has issued a calendar which contains a very beautiful reproduction of an oil painting entitled "On a Point." It represents two dogs in the attitude of "pointing," and the coloring of the animals and of the surrounding grass and shrubbery is very realistic.

THE LA FAVORITE RUBBER MANUFACTURING COMPANY, Paterson, N. J., departs from conventional designs in calendars and has produced one for 1899 which no doubt will be popular. Each of the twelve sheets containing the monthly calendars bears the portrait of one of the most prominent American military or naval commanders in the Spanish-American war, including Dewey, Miles, Sampson, Shafter, etc., together with a battle scene on sea or land. This calendar will no doubt be preserved as a memento of the recent war.

Trade and Industrial Notes.

THE ROLAND F. OAKES COMPANY, Rutland, Mass., has purchased two 40-hp engines for electrical purposes from the Ball Engine Company, Erie, Pa.

"WE ARE all one year older. Well, never mind," observes Mr. Charles D. Shain, 136 Liberty Street, New York, in his New Year's greetings to the trade. It reminds us that time is still as active as ever. But some consolation may be derived from the thought that we are all being dealt with alike in this regard.

DRAFT WITHOUT A CHIMNEY.—In its interesting and attractive circular entitled "Draft Without a Chimney," the B. F. Sturtevant Company, Boston, Mass., tells why its tall chimney has been taken down, how draft is now produced and how an annual fuel saving of nearly $1000 is secured. A copy of this circular may be obtained on application to the company.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has taken the selling agency for the two-ball lamp adjuster. Great claims are made for this adjuster as to simplicity, durability, etc. There being no springs or special mechanism used in the device, it cannot get out of order, and is practically indestructible. It is inexpensive, and at the same time ornamental, and will undoubtedly become popular.

MESSRS. JAMES J. MURRAY & CO., Philadelphia, Pa., have just published their new catalogue, No. 3, descriptive of and illustrating etched incandescent shades and globes. The cuts in this catalogue show a very high grade of glass globes and shades in opal, flint and colored designs for gas and kerosene as well as for electric light purposes. The firm also manufactures battery jars. A copy of this catalogue should be on file in every supply house.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Chicago, Ill., anticipating the increasing demand and use for motors during the coming year, has enlarged its factory and made preparation for doing at least double the business which it did last year. This company is now in a position to supply the world with starting boxes of the most approved designs, and can make immediate shipment from stock of all standard sizes up to 50 horsepower.

THE WESTERN ELECTRIC COMPANY, of Chicago, will send, upon application, copy of Bulletin No. 100, describing fusible cut-outs for transformers, lines and switchboards. These cut-outs are of the SKC types, and are of the most modern design and construction. They are adapted for any voltage between 1200 and 6000 volts. The cut-outs of the switchboards are of the multiple type, and if one fuse blows out another can be immediately switched into the circuit. The fuses for transformers and lines are mounted on weatherproof boxes, and all details have been carefully worked out.

RAW SILK WIPERS are used very extensively for cleaning machinery, and they are said to be far more economical and superior to cotton waste. The Edison Electric Light Company, of Philadelphia, states that the actual cost of silk wipers used in its station is 20 per cent. of the cost of the waste previously used in the same length of time. The American Silk Manufacturing Company, 311 Walnut Street, Philadelphia, manufactures these wipers and recommends them for use in all electric light and power stations. It is stated that they are recommended and endorsed by the Boards of Fire Underwriters of St. Louis and Philadelphia.

THE CHICAGO RHEOSTAT COMPANY, Chicago, Ill., will be represented in England and on the Continent by the General Electric Company, Limited, of London, England. This arrangement is one of the results of the recent visit to this country of Mr. H. Bevis, of London. The products of the Chicago Rheostat Company will be the subject of a pamphlet to be issued shortly by the General Electric Company, it having recently placed large orders for these goods, a well-assorted line of which will be carried in stock in London. European orders and inquiries should be addressed to the London office.

AMERICAN ELECTRIC VEHICLES FOR EUROPE.—A Chicago dispatch, dated December 28, states that the Fischer Equipment Company, of that city, has made a contract with Count de Jotemps, of Paris, president of the American Motor General Agency, to supply electric vehicles for the European market during the next ten years. It is stated that the contract just closed calls for vehicles to the value of $1,000,000, and that the first shipment from Chicago will be made in January. Illustrations and description of the Fischer Company's vehicles were published in THE ELECTRICAL WORLD of December 10, 1898.

MR. FERDINAND SCHWEDTMANN, general superintendent of the Wagner Electric Manufacturing Company, St. Louis, Mo., has just returned from a European trip in connection with the business of the company. Mr. Schwedtmann made a hurried trip to the leading centres in Europe with the view to the extension of his company's business, and made a general survey of the European methods of manufacture. The Wagner Company is now executing some important contracts which, it states, will attract considerable attention, both in this country and abroad. As this work is all under the engineering and manufacturing direction of Mr. Schwedtmann, his trip will no doubt yield very material results.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has for distribution to the telephone trade a sample card of such of its Paranite wires as are particularly adapted to telephone uses. The card shows samples of No. 19 plain and braided single-conductor Paranite of a high insulation, suitable for telephone work. It also shows samples of No. 19 duplex twisted Paranite wire, in three styles, the first being plain with one conductor of red rubber, and the other with black rubber insulation; another sample with black and red rubber insulation, but braided over with a regular saturated weather-proof braid. There is still another sample of the No. 19 two-conductor twisted, having red and black rubber insulation, but having glazed braid instead of the saturated braid. One of these sample cards can be had for the asking.

THE AMERICAN ELECTRIC VEHICLE COMPANY, 1545 Michigan Avenue, Chicago, writes that the contract and agreement heretofore entered into between that company and the Indiana Bicycle Company, whereby the latter concern undertook to build American electric vehicles, was cancelled and terminated on October 4, 1898, and that the Indiana Bicycle Company now has no right or authority to build or sell the American electric vehicles or vehicles made in accordance with the patterns or under the patents of the American Electric Vehicle Company, and has no authority to deliver such vehicles, although contracted for or commenced during the continuance of the contract. The American Electric Vehicle Company states that its vehicles are covered by letters patent owned by it, and that any purchasers of such vehicles from unauthorized persons will render them liable for infringement.

A HANDY COMBINATION FOOT RULE AND WIRE GAUGE.—The Standard Underground Cable Company is distributing to the trade with its compliments a three-part combination foot rule and wire gauge which, no doubt, will be found very useful. When it is folded up it measures about 4½ inches in length, and, being made of celluloid, is quite flexible and takes up practically no room in the vest pocket A foot rule is a very useful instrument to every business man, and the addition of the wire gauge in this case makes this rule particularly valuable to electrical men. The company reminds the recipient that it is "on earth" and after orders, large or small, for bare copper, iron or steel wire, weather-proof, annunciator, office wire, galvanized steel strands, rubber-covered wire or cables, lead-covered cables for underground or aerial use, armored submarine cables, cable hangers, terminal or junction boxes and underground conduits. The company has been in the business sixteen years.

LORD'S BOILER COMPOUND.—Mr. George W. Lord, Philadelphia, Pa., manufacturer of the boiler compound intimately associated with his name, has given almost his entire attention for the last thirty years to the one business of manufacturing this article. This compound, as is well known among steam men, chemically treats feed water for steam boilers. Mr. Lord's long experience has enabled him to attain the position of an authority on this important subject. A glance into the offices, mill and shipping department of Mr. Lord's establishment tells the story of that gentleman's ability and perseverance. It is stated that ever since he has been engaged in the manufacture of his boiler compound the business has shown a decided increase each year over that of the previous year. He ascribes his success to a thorough knowledge of the business, undivided attention to all of its details, and advertising his product wherever steam is used. These principles strictly adhered to no doubt will carry any business through to success.

THE RUSSELL-TOMLINSON ELECTRIC COMPANY, 39-41 Cortlandt Street, New York, is manufacturing a new telephone for private line use which is exceedingly compact and efficient. The apparatus is contained in an oak case well finished, 4¼ inches wide, 6 inches long and 3½ inches deep. It is attached to a back for the purpose of fastening to the wall. The receiver is of the watch-case type, and when not in use hangs on a hook at the side of the box. The call-bell is of the well-known vibrating type, and is placed at the top of the box. A coal grain transmitter is used, and from an inspection of one of the instruments the entire outfit seems to be well and carefully made. It is strong and durable, and all of the metal parts are nickel-plated. Anyone desiring a private line set would do well to communicate with this company. This outfit certainly possesses merit, and once it has become known to the trade will no doubt meet with considerable favor. The instruments are guaranteed to work perfectly on lines 2000 feet or less in length and to give satisfaction in every way. Three cells of open-circuit battery at each end will operate a line of 2000 feet, shorter lines taking a correspondingly less amount of battery power.

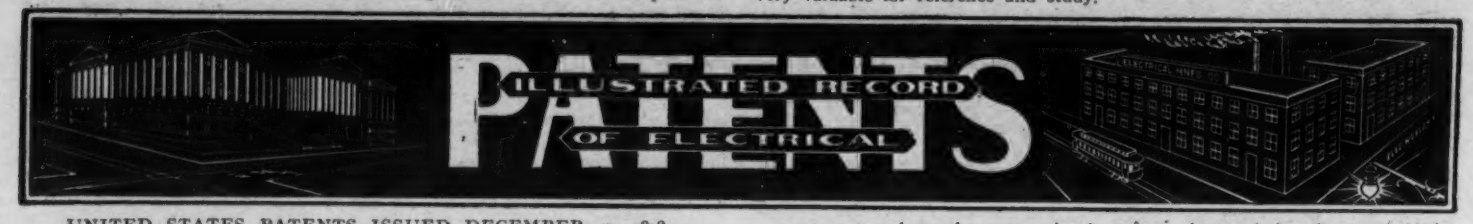
PROSPERITY IN THE ELECTRICAL BUSINESS IN 1898.—The General Electric Company states that as far as its information and experience goes there has been a most healthy and satisfactory growth in the electrical business during the year 1898, which has been reflected, not only in the increased orders of manufacturing companies, but in the increased business of local lighting and power companies. The General Electric Company's orders during the year were considerably in excess of those in the year previous in almost every line of electrical apparatus and supplies, and the indications for the new year are most encouraging. With the improved quality of electrical apparatus and supplies, together with the low prices now prevailing, and with the increased attention the local and power companies are giving to the question of cheapening the cost of production of current and of adopting a comprehensive system of charges to customers (based directly upon the cost of the product) the electrical business as a whole was never in so sound or healthy a condition in this country as it is at the present time, and, as a consequence, capital for investment is attracted to the industry as it has never been before.

THE JEFFREY ELECTRIC LOCOMOTIVES.—The Jeffrey Manufacturing Company, Columbus, Ohio, has issued a pamphlet giving considerable information and many views of its electric mine locomotives. The Jeffrey locomotives have been used for various purposes during the past ten years, and have demonstrated their excellence with respect to mechanical and electrical construction. On the pages of the pamphlet are illustrated a few of the various types of locomotives which the Jeffrey Company builds, these having been reproduced from photographs taken of locomotives ranging in size from 2 tons to 15 tons. The aim of the Jeffrey Company in building these locomotives has been to produce a machine which will operate at minimum expense, and that this has been successfully done the company points, as evidence, to the fact that a great number of these locomotives are in operation, and that the demand for them is increasing. The company also manufactures a switching locomotive, which is especially designed for switching and hauling cars on surface roads. They are built with either cab or with open platform. The motors and controlling apparatus are of the standard mine type and trap doors are provided in the floor for easy access to the motors and running gear. The Jeffrey Company is prepared to furnish locomotives of this type up to 6000 pounds draw-bar pull.

THE ORIENT ELECTRICAL COMPANY, Youngstown, Ohio.—Never since this company began the manufacture of incandescent lamps has the business been so good as it is at the present time, it being difficult to keep up with the orders coming in, thus making the running of the factory overtime a matter of necessity. Some time ago the company decided to place upon the market a new lamp, and realized that unless the new product embodied all the essential features necessary to a strictly high-grade lamp all effort would be in vain. The task was then undertaken in a thorough and systematic manner. The company's plant was equipped during the summer of 1898 with all the latest and most improved instruments and appliances known to the lamp business. Neither time nor money was spared in procuring these things, realizing that with old and imperfect equipment satisfactory results could not be hoped for. While the changes in the factory were being made extensive preparations were also being made for the adoption of new processes in the manufacture of the lamps, many of which, it is stated, are not used by any other lamp manufacturer. Hence, before the lamp season of 1898-99 commenced, the company had completed and perfected arrangements and had the new lamps thoroughly tested under all the varying conditions to which they might be subjected in actual use. These lamps are sold on their merits, and the demand for them is constantly increasing. This the company attributes to the fact that the new lamp is a success in every sense of the word.

PACKARD LAMPS AND TRANSFORMERS.—The New York & Ohio Company, Warren, Ohio, has issued two separate catalogues, one on the subject of Packard lamps and the other entitled "Transformers and Their Profitable Use." The lamp catalogue is particularly interesting, in that it represents a departure in the usual method of illustrating incandescent lamps. The cuts used have a black background, against which the glass bulb stands out most effectively and artistically. A very valuable table is given, showing the efficiency and average life of lamps at various voltages. The Packard incandescent lamp has been on the market since 1889, the New York & Ohio Company being one of the first independent concerns to engage in the manufacture of lamps. In the company's present product the curve of candle-power is very nearly a straight line, showing a very slight rise in the first fifty hours of burning only. This maintenance of candle-power in the lamp, it is stated, is not obtained at the expense of efficiency, as the total watts consumed at no time exceeds its initial value. The subject matter of the transformer catalogue is from the pen of Prof. Dugald C. Jackson, of the University of Wisconsin. It is a well-written article, and the information contained therein, together with the instructions for testing, should be of general value to all users of transformers. Some excellent illustrations give various views of the Packard transformers, and curves are given representing the performance of these transformers. Professor Jackson sums up by giving the most important principles in a few paragraphs: "In order that each transformer may carry a load for as many hours as possible each day, modern transformers are used connected to secondary mains, which cover a considerable district. Increasing the size of units into which the total transformer capacity is divided reduces the cost per unit, and paralleling the secondaries permits the reduction of the number of units without sacrificing regulation or reliability. It also tends to increase the hours of load carried by each transformer, and therefore reduces

the total capacity required to give a total station load. The transformers should regulate within 2½ per cent. between no load and full load, and the station pressure should be set so that the lamps are run at normal pressure when the average load is on. Then the transformers need never cause a defect in regulation greater than from 1 to 1¼ per cent. between average loads. Core losses should be carefully looked to and large transformer units adopted for the purpose of reducing the total losses." Mr. Henry W. Wiswell contributes an article giving general instructions for testing transformers. It is illustrated by various diagrams, showing connections, etc. These two catalogues of the New York & Ohio Company differ widely from the usual trade publication, as they contain much information of real value that will no doubt be very valuable for reference and study.



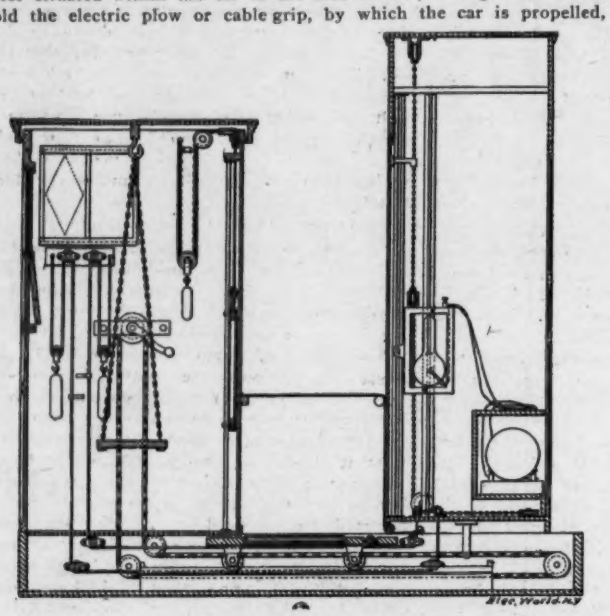
UNITED STATES PATENTS ISSUED DECEMBER 27, 1898.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

616,507. INCANDESCENT ELECTRIC-LAMP SOCKET AND BASE; C. Van Deventer, of New York, N. Y. App. filed April 1, 1898. The combination with a socket made with two covers and fastened together by a bayonet-joint, and provided with slots respectively lettered, which slant in opposite directions, of a circuit-closer, whose shaft passes through those portions of the slots which overlap.

616,513. APPARATUS FOR MAKING OBSERVATIONS BY MEANS OF ROENTGEN OR X-RAYS; J. Wertheimer, of Paris, France. App. filed Nov. 19, 1897. In an apparatus, the combination with two casings, one being movable toward and from the other, and a screen carried within one casing, of a frame arranged within the movable casing, a vacuum or fluorescent tube carried by the frame, a vertical post having a rib, and pivoted at its ends upon vertical pivots, and stop-pins carried by the frame and adapted to be engaged by the rib on the post when the latter is turned in the manner and for the purpose described.

616,585. MECHANISM FOR STREET CARS; F. S. Pearson, of Boston, Mass. App. filed Sept. 14, 1897. In street cars, in combination, an elevator situated within the car at the side thereof, arranged to receive and hold the electric plow or cable grip, by which the car is propelled, and



No. 616,513.—Apparatus for Making Observations by Means of Roentgen or X-Rays.

mechanism by which the elevator is raised from either end of the car, whereby the plow or grip is raised from the conduit into the car, substantially as described.

616,612. ARMORED ELECTRIC CABLE; E. T. Greenfield, of New York, N. Y. App. filed April 13, 1898. A flexible armored electric cable, consisting of an insulated conductor having two or more metallic armor strips spirally wound thereon and curved in opposite directions, substantially as described.

616,620. ELECTRIC INCANDESCENT LAMP; H. F. Joel and F. Fanta, of London, Eng. App. filed July 29, 1896. In combination in an incandescent lamp, a globe adapted by its shape to be blown in thin glass with resisting strength to external atmospheric pressure, a reflecting surface carried thereby of parabolic or spheroidal form, and an incandescent filament within such reflector bent into such a form from a continuous length, to provide a body of several convolutions lying in a surface coaxial with and equidistant from the said reflecting surface on all sides of the same, to produce a concentrated, uniform and directive light, substantially as described.

616,669. RECORDING DEVICE FOR MEASURING INSTRUMENTS; A. H. Hoyt, of Penacook, N. H. App. filed Aug. 13, 1897. In an electrical measuring instrument, a stylus moving over a renewable scale, back and forth in the same path, and tracing by such movement a line which by its length indicates the maximum reading of the instrument during a given time.

616,673. ELECTRIC MOTOR AND METHOD OF CONTROLLING SAME; C. W. Kennedy, of Rutledge, Pa. App. filed April 22, 1898. The method of controlling a varipolar electric motor independently of resistance external to the motor circuit proper, it consisting in starting the motor as a bipolar machine with a relatively high internal resistance and thereafter constantly decreasing the internal resistance of the field circuit, and finally putting the machine into a full-load condition as a multipolar motor, substantially as described.

616,714. AUTOMATIC TELEPHONE-EXCHANGE; F. A. Lundquist, J. Erickson, and C. J. Erickson, of Lindborg, Kan. In an electrical exchange, the combination with a switchboard, and a series of contact-points

No. 616,612.—Armored Electric Cable.

arranged in a plurality of rows, of a movable carriage, a second carriage mounted on the first-named carriage and movable at an angle into contact with either of said contact-points, substantially as described.

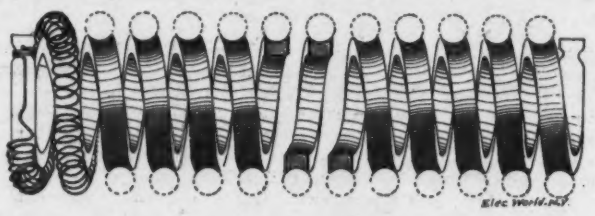
616,718. TELEPHONE GRAVITY SWITCH; C. T. Mason, of Sumpter, S. C. App. filed May 3, 1898. The combination of a gravity lever having a T-head on the opposite side of its fulcrum from its receiver-support, the lifting spring, means for electrically connecting the gravity lever to the same line terminal for both the ringing and talking circuits, two insulated contact springs arranged on one side of the head and trending toward the same, a fixed non-conducting rest-block arranged on the same side of springs as the head and limiting the motion of the springs toward the head, and a third spring arranged on the opposite side of the head from the springs and having a trend and a limited movement toward the head, substantially as described.

616,722. RAILWAY SIGNALING DEVICE; F. M. Myers, of Windsor, Mo. App. filed April 2, 1898. In a railway signal, the combination with a conductor extending parallel with one of the track rails of a signaling device carried upon an engine or car and normally in circuit with the conductor and track rails, a battery normally out of circuit with the signaling device, and means for placing the battery in circuit with the signaling device at predetermined points along the track, substantially as described.

616,755. BINDING POST FOR ELECTRICAL, TELEPHONIC, OR TELEGRAPHIC INSTRUMENTS; J. A. Williams, of Cleveland, Ohio. App. filed May 25, 1898. A binding post comprising a plate, a saddle or bearing for the wire, a screw having a head or member overlapping the saddle, and a stop arranged to limit the inward movement of the screw, substantially as described.

616,779. ELECTRICAL SAFETY LAMP FOR MINERS; C. F. Rancke, of Berlin, Ger. App. filed April 18, 1898. A lamp having a main and an auxiliary burner, a cap mounted to swing and to enclose one of said burners, and a switch controlling the circuits of said burners and having a stop-lug coating with the cap to prevent the further movement of the switch after the switch has been closed, substantially as described.

616,800. ELECTRIC HEATER; J. F. McElroy, of Albany, N. Y. App. filed Oct. 13, 1898. An electric heater, consisting of a supporting helix, and a resistance in the form of a compound helix arranged in continuous contact with each convolution of the supporting helix in such a manner that the spaces between the convolutions of the supporting helix shall register sub-



No. 616,800.—Electric Heater.

stantially with the spaces between corresponding convolutions of the resistance helix.

616,824. UNDERGROUND ELECTRIC RAILWAY SYSTEM; F. H. Chamberlain and G. B. Coleman, of Washington, D. C. App. filed Dec. 2, 1897. The combination with the motor current collector and supply conductors of an electric car, a plurality of interchangeable pairs of leads between the motor and supply conductors connected to the current collector, a switch for electrically connecting one or another of said pairs or sets of leads with the supply conductor, and electrical means for controlling said switch.